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OF LONDON.

1916, pp. 1-448,

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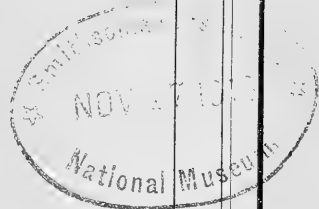
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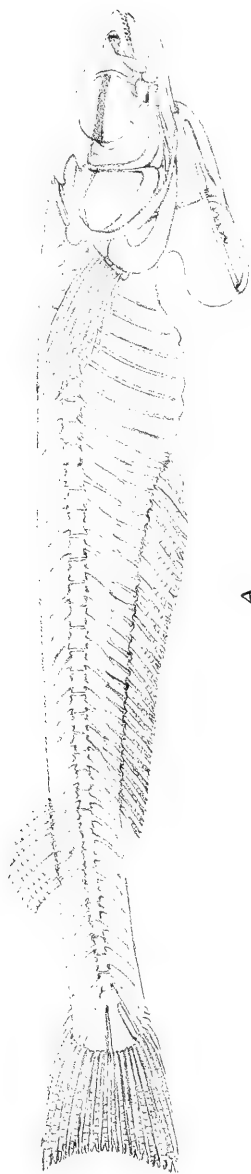
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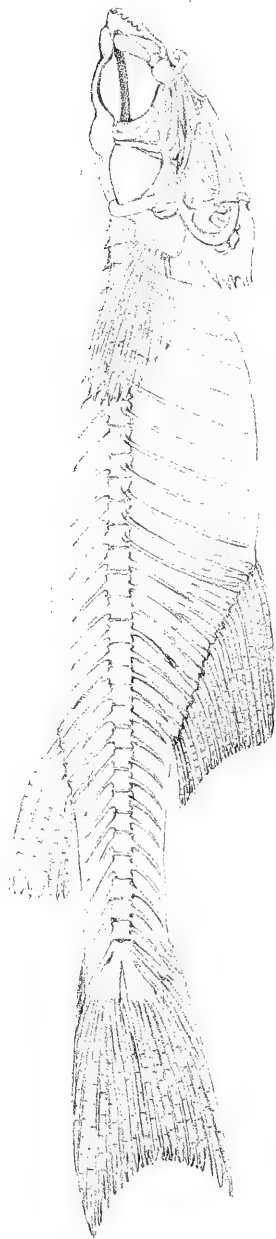
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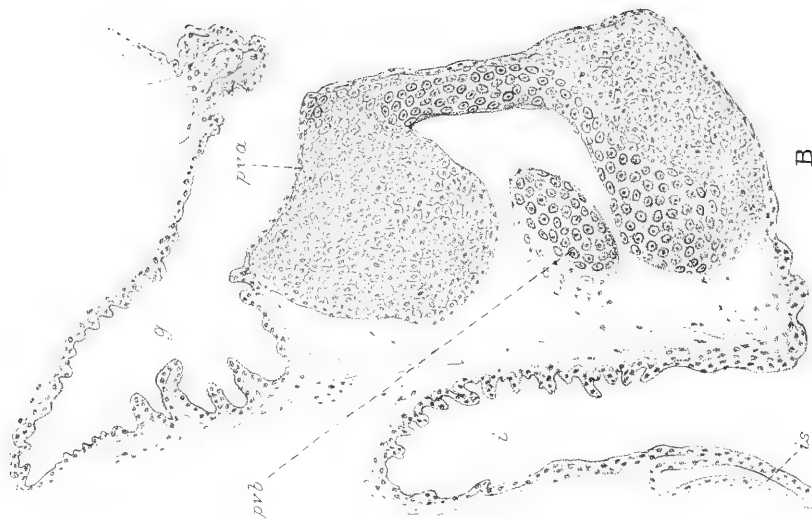
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B.



A

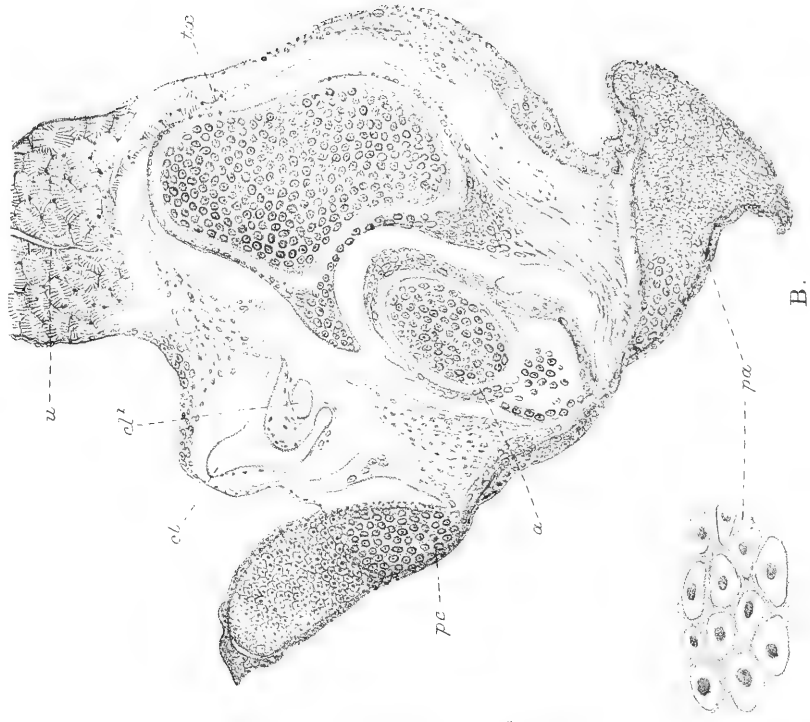
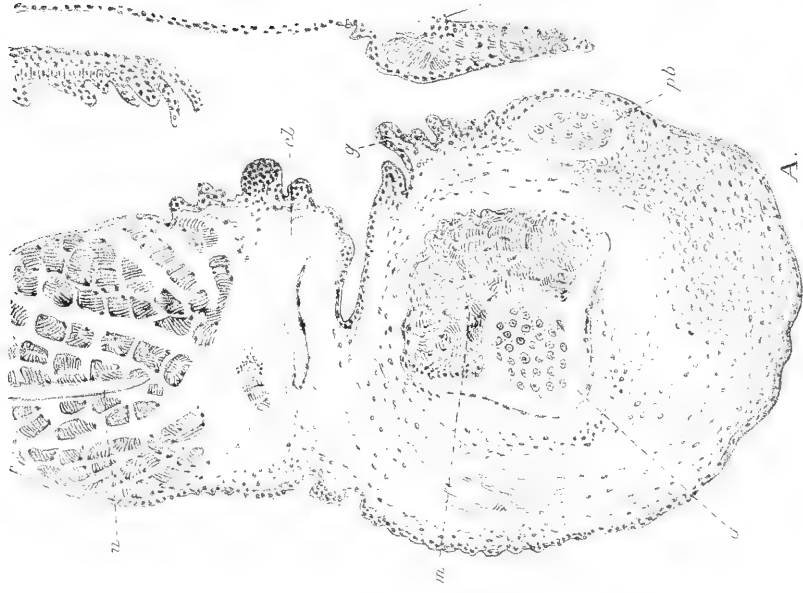


B

G.M. Woodward del. coll. lit.

High imp.

NEOSTETHUS LANKESTERI.



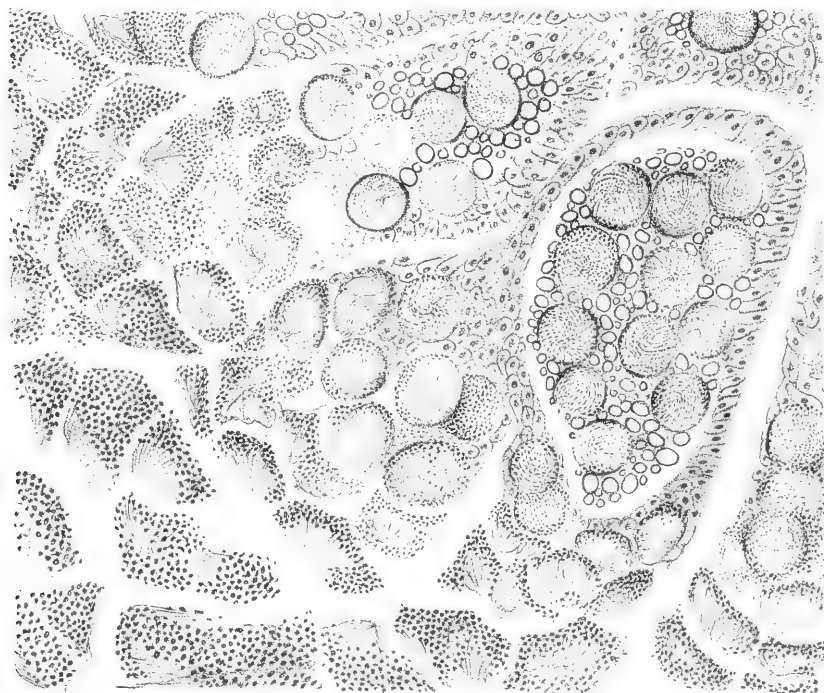
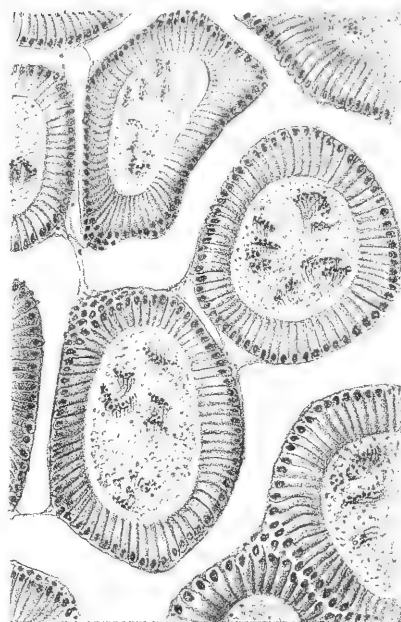
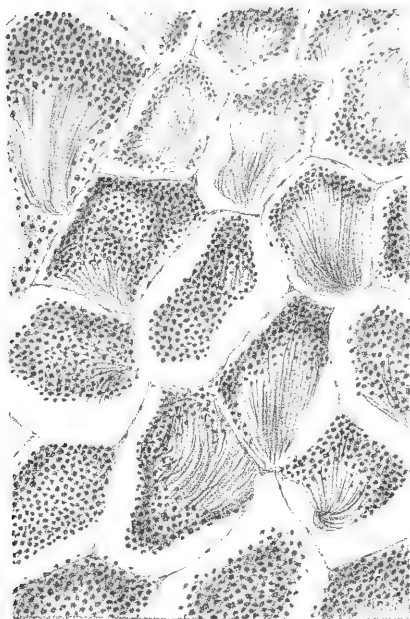
G. M. Woodward del. et lith.

Huth imp.

A. NEOSTETHUS. B. PHALLOSTETHUS.

A.

B.



G.M. Woodward del. et lith.

C.

Huthimp.

A, B. PHALLOSTETHUS. C. NEOSTETHUS.

PROCEEDINGS

OF THE

GENERAL MEETINGS FOR SCIENTIFIC BUSINESS

OF THE

ZOOLOGICAL SOCIETY OF LONDON

PAPERS.

1. The Morphology of the Cyprinodont Fishes of the Subfamily Phallostethinae, with Descriptions of a new Genus and two new Species. By C. TATE REGAN, M.A., F.Z.S.

[Received November 8, 1915 : Read November 23, 1915.]

(Plates I.-IV.* and Text-figures 1-15.)

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1. Introduction.

In 1913 I described an extraordinary little Cyprinodont fish from Johore, and named it *Phallostethus dunckeri* (Regan, 11). Some more fishes from the same locality have been sent to me

* For explanation of the Plates see p. 25.

for description; they represent a new genus, *Neostethus*, related to *Phallostethus*, and belong to two new species, *N. lankesteri* and *N. bicornis*.

Of *Neostethus lankesteri* there are six specimens, all about 30 mm. in total length; five are adult males and the other is an adult female. They come from the Muar River (brackish-water) and from Singapore. Some features in their structure, such as the number of vertebræ and the general relations of the viscera, have been elucidated by prolonged clearing with oil of cloves, but the detailed account of the structure of the male fish is based on the study of a series of transverse sections. Of *N. bicornis* there are three examples, two males (21 and 25 mm. long)—one immature, the other nearly adult—and a female of 24 mm.; these are from Kuala Langat (brackish-water).

Phallostethus is redescribed and is compared with *Neostethus*.

2. Structure of Female NEOSTETHUS LANKESTERI *, gen. et sp. n.

a. EXTERNAL CHARACTERS.

Form elongate, strongly compressed. Head rather small; mouth terminal, strongly oblique, protractile, with one or two series of conical teeth in the jaws; eyes large, lateral. Scales very similar in structure to those of *Panchax*; 34 to 36 in a longitudinal series. Dorsal fin of 5 or 6 rays, above the end of the rather long anal, which has 15 or 16 rays; caudal emarginate; pectorals 10 or 11-rayed, placed rather high. Anus (text-fig. 12, B, a.), genital aperture, and urinary opening behind each other in middle line below bases of pectoral fins; behind them abdomen compressed to an edge bearing a rayless fringe (text-fig. 12, B, f.); just behind anus a pair of papillæ (text-fig. 12, B, p.) (? vestigial pelvic fins †), one much larger than the other, that partly cover a depression into which the oviduct and ureter open.

b. SKELETON.

The skeleton is typically Cyprinodont and essentially similar to that of *Panchax*, except that the hæmal arches of the caudal vertebræ are not expanded, as the air-bladder does not extend back into the tail. The vertebræ number 34 or 35 (15-16+19).

c. VISCERA.

The air-bladder occupies the posterior part of the abdominal cavity; it is large, simple, and thin-walled, except an anterior

* I have ventured to name this species in honour of Sir Ray Lankester, K.C.B., F.R.S., to whom I am indebted for many acts of kindness and much sound advice. Moreover, it seems to me not inappropriate that this little fish, whose structure presents more than one problem for the consideration of students of animal morphology, should bear the name of the most distinguished morphologist of our time.

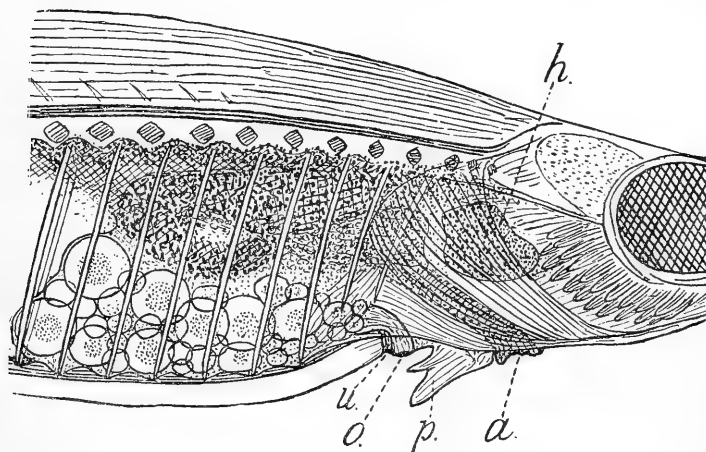
† In *Phallostethus* the postanal papillæ are supported by a pair of minute skeletal elements that may be vestigial pelvic bones.

part, tapering forwards, that has thick glandular walls. There is no trace of a pneumatic duct.

The short œsophagus leads into the stomach, which is simple, without cæcum or pyloric appendages; the intestine forms a single coil just in front of the air-bladder, and then runs downwards and forwards to the anus. The liver is large, and there is a well-developed spleen situated on the anterior part of the intestinal coil.

The kidneys extend from below the basioccipital to the posterior end of the abdominal cavity; they are paired, but not enlarged, anteriorly, unpaired posteriorly; the ureters leave the kidneys

Text-figure 1.



Neostethus lankesteri, ♀. Part of head and abdominal region cleared and viewed as a transparent object ($\times 10$). The ovary is clearly visible, lying in front of the air-bladder and below the alimentary canal.

h., heart; a., anus; p., postanal papillæ; o., opening of the oviduct; u., opening of ureter.

above the anterior part of the air-bladder and soon unite to form a single duct that runs downwards and forwards below the intestine. The ovary is unpaired and lies in front of the air-bladder and below the intestine; it narrows forwards, and the very short oviduct arises from its anterior end. The ova are comparatively few and large.

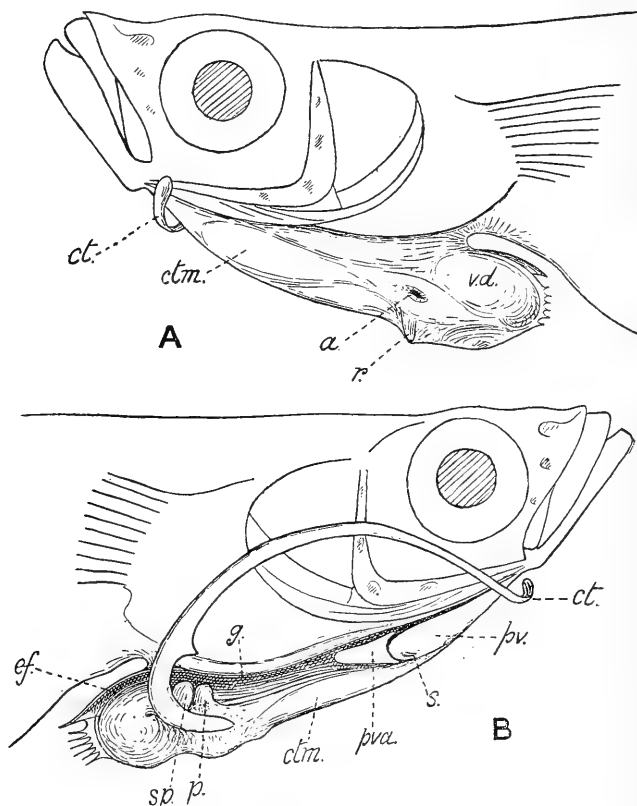
Except for modifications correlated with the thoracic position of the anus and urino-genital apertures, *e. g.* that the air-bladder is posterior instead of superior, the intestine runs forwards instead of backwards, etc., the visceral anatomy is essentially similar to that of the Fundulinæ.

3. *Structure of Male* NEOSTETHUS LANKESTERI.

a. EXTERNAL CHARACTERS.

The male differs from the female externally in the presence of the priapium (text-fig. 2), a fleshy appendage that lies below the

Text-figure 2.



Neostethus lankesteri, ♂. Head and priapium ($\times 10$). A, proctal side; B, aproctal side.

ct., ctenactinium; *ctm.*, ctenactinial muscle; *a.*, anus; *r.*, end of priapial rib; *v.d.*, terminal coil of vas deferens; *pv.*, pulvinulus; *pva.*, pulvinular appendage; *s.*, pulvinular spine; *g.*, glandular groove; *ef.*, efferent groove; *sp.*, seminal papilla; *p.*, intrasulcar prominence.

head and the anterior part of the body, to which it is attached for the greater part of its length, only the posterior end being free. Anteriorly the priapium is confluent with the isthmus;

further back it increases in size and is well-defined; owing to a strong constriction of the body just behind its attachment, the posterior part of the priapium projects but little beyond the general outline of the abdominal region.

On one side, the proctal side, which may be either right or left, may be seen the anus (*a.*); above and behind it can be seen the outline of the enlarged terminal coil of the vas deferens (*v.d.*), occupying most of the free posterior part of the priapium, which ends in a membranous fringe, produced into some half-dozen slender processes. On the proctal side a shallow groove marks the boundary between the priapium and the body of the fish, but on the other side, the aproctal side, there is a much deeper groove, margined above by a thick fold of the integument; this groove is lined by a glandular epidermis, and may be termed the glandular groove (*g.*). Posteriorly a dermal fold arises from the inner wall of the groove, and this fold is continued backwards on the free part of the priapium as the roof of another groove, leading from the glandular groove to the end of the priapium; this may be termed the efferent groove (*ef.*).

The enlarged part of the vas deferens lies below the floor of the efferent groove; here it is running backwards, and at the end of the priapium it curves round from the proctal to the aproctal side and then runs upwards and forwards, ending in a seminal papilla (*sp.*), which opens into the glandular groove, the terminal aperture being a wide slit. Directly in front of the seminal papilla is a papilliform projection (*p.*), which may be termed the infrasulcar prominence. Below the infrasulcar prominence is the articulation of the ctenactinium (*ct.*), a long and slender movable bony appendage that curves backwards and upwards, then forwards to below the eye, and, finally, downwards and across beneath the chin; a short pointed process, directed outwards and downwards, arises from its concave edge above the infrasulcar prominence.

Further forwards, a rather soft appendage, subconical in form and with its apex directed backwards, lies in the glandular groove; at its base it is separated by a deep constriction from a lateral mass of tissue that tapers forwards to the anterior end of the priapium. This mass of tissue may be termed the pulvinulus (*pv.*) and its appendage the pulvinular appendage (*pva.*); a small antorse spine (*s.*) projects from the posterior part of the pulvinulus, and a branch of the glandular groove runs forwards between the priapium proper and the lower part of the pulvinulus; this infrapulvinular groove narrows forwards and disappears a little in advance of the level of the pulvinular spine.

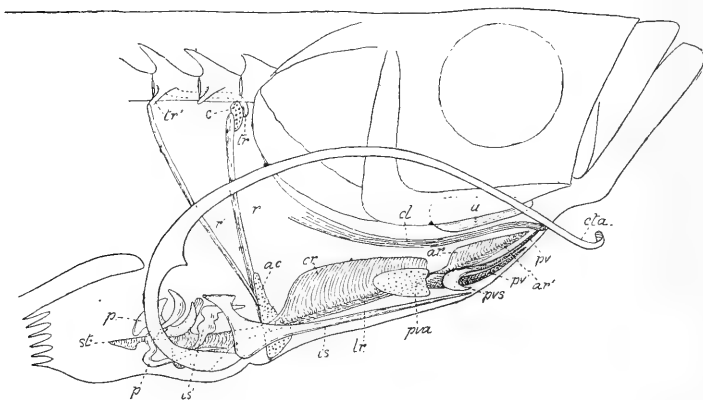
b. SKELETON (Pl. I. B, and text-fig. 3).

This differs from that of the female in that one of the cleithra, the third vertebra, and the first pair of ribs are modified in

connection with the priapium, whilst the priapium itself has a special skeleton.

Cleithra.—The cleithrum of the proctal side is normal and ends anteriorly below the angle of the præoperculum. That of the aproctal side is produced into a slender process (*cl.*) that extends forward to below the attachment of the urohyal; this process lies between the isthmus and the priapium; it is somewhat expanded transversely (Pl. I. A), and anteriorly it spreads downwards on each side of the priapium, almost enclosing it.

Text-figure 3.



Neostethus lankesteri. Skeleton of priapium from the aproctal side ($\times 12$) (diagrammatic).

cta., ctenactinium; *u.*, urohyal; *cl.*, cleithrum; *tr.*, *tr.*', transverse processes of third vertebra; *c.*, cartilage; *r.*, *r.*', first pair of ribs; *ac.*, antepleural cartilage; *pva.*, pulvinular appendage; *pvs.*, pulvinular spine; *pv.*, outer, and *pv.*', inner pulvinular bones; *is.*, anterior, and *is.*', posterior infrascapular bones; *p.*, papillary bone; *a.r.*, vertical, and *a.r.*', horizontal anterior ridges of axial bone; *lr.*, its lateral ridge; *cr.*, its main crest; and *st.*, its terminal style.

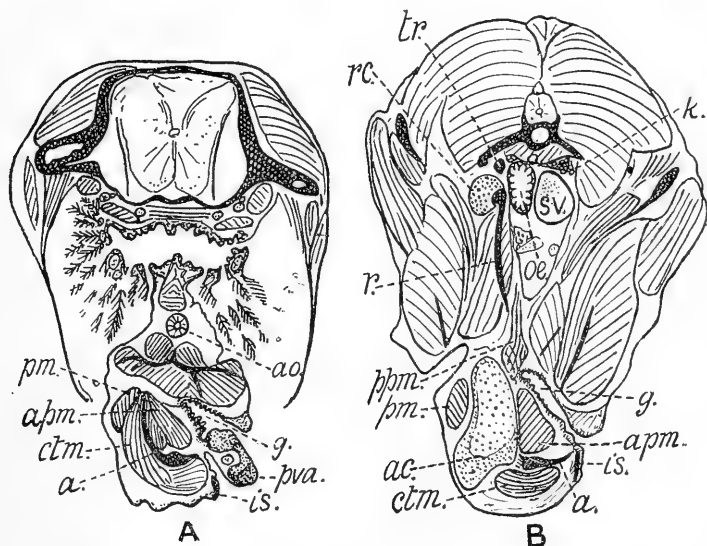
Third vertebra.—The transverse process of the aproctal side (*tr.*') is normal, but that of the proctal side (*tr.*) is much stronger; proximally it is directed outwards at right angles to the centrum, then it runs forwards below the transverse process of the second vertebra (text-fig. 4 B), until it reaches the level of the first vertebra, when it curves downwards and ends.

First pair of ribs.—These are attached proximally to the transverse processes of the third vertebra; the rib of the aproctal side (*r.*') is not particularly strong, but it is very long and runs downwards and forwards into the priapium; the rib of the proctal side (*r.*) is much stouter and runs downwards right to the ventral surface of the priapium below the anus (text-fig. 2, *r.*); proximally a nodule of cartilage (*c.*) intervenes

between the end of the rib and the posterior face of the de-curved part of the transverse process. A mass of cartilage, the antepleural cartilage (*ap.*), lies in front of the distal ends of this pair of ribs and embraces them laterally; this mass is to a large extent composed of parenchymatous cartilage, but in the centre approaches true hyaline cartilage in structure (*cf.* text-fig. 4, B).

Axial bone of the priapium.—This extends nearly the whole length of the priapium; in front of the articulation of the cten-actinium it has the form of a rod of cartilage enclosed in a cylinder of bone (Pl. III. A, *a.*) that bears certain crests and ridges, namely, (1) the anterior ridges, the upper (*ar.*) vertical, the lower (*ar.*)

Text-figure 4.



Neostethus lankesteri, ♂. Transverse sections ($\times 18$): A, through postorbital part of head and base of pulvinular appendage; B, through second vertebra and antepleural cartilage.

ao., aorta; *g.*, glandular groove; *pva.*, pulvinular appendage; *a.*, axial bone; *is.*, infrasulcar bone; *ctm.*, ctenactinial muscle; *pm.*, muscle of proctal side; *apm.*, muscles of aproctal side; *ppm.*, pleuro-priapial muscle; *ac.*, antepleural cartilage; *r.*, priapial rib; *rc.*, cartilage; *tr.*, transverse process of third vertebra; *k.*, kidney; *oe.*, cesophagus; *sv.*, sinus venosus.

nearly horizontal and aproctal; these increase in height backwards and end abruptly at the level of the pulvinular spine. (2) The main crest (*cr.*): this rises obliquely from the proctal side of the axial bone and then curves upwards until it is vertical (text-fig. 4 A, *a.*); it commences a little behind the end

of the anterior ridges and ends in front of the priapial ribs. (3) The lateral ridge (*lr.*), on the aproctal side from the level of the end of the pulvinular appendage to the level of the priapial ribs; this ridge almost reaches the surface at the lower margin of the glandular groove. The axial bone passes backwards on the aproctal side of the priapial ribs and antepleurale cartilage, and in the region of the anus it becomes stouter and expands downwards; the ctenactinium (*cta.*) is attached to the aproctal side of this part of the axial bone. In the region of the seminal papilla the axial bone extends upwards nearly to the glandular groove, and behind this it contracts to form a terminal style (*st.*) that runs backwards and ends just in front of the transverse portion of the terminal coil of the vas deferens.

Anterior infrasulcar bone (*is.*).—This is a laminar bone that lies near the surface on the aproctal side. It is broad posteriorly and tapers anteriorly; behind it extends from the floor of the glandular groove under the base of the infrasulcar papilla to outside the proximal end of the ctenactinium; for the greater part of its length its upper edge is just below the edge of the lateral ridge of the axial bone; anteriorly it lies within the inner surface of the infrapulvinular groove (Pl. II. B, *is.*) and is quite a slender bone. Near its posterior end, where its lower edge overlaps the end of the ctenactinium, it bears an inner knob to share with the axial bone in supporting that appendage.

Posterior infrasulcar bone (*is'.*).—A bone whose expanded upper surface lies just below the floor of the glandular groove, below the anterior part of the seminal papilla; it is a solid bone that extends downwards and inwards on the aproctal side of the axial bone; from its upper surface it sends forwards a laminar process that runs below the anterior infrasulcar bone into the base of the infrasulcar prominence.

Papillary bone (*p.*).—A bone that supports the seminal papilla, which it enters from behind and below, and then divides into three branches that expand into laminae lying just below the skin, one on the inner side of the papilla and two, an upper and a lower, on its outer side. Before entering the papilla the bone is a slender rod that curves downwards across nearly to the ctenactinium and then tapers forwards and inwards, ending a little in advance of the seminal papilla on the aproctal side of the axial bone (*cf.* Pl. II. A, and text-fig. 7 A, *p.*).

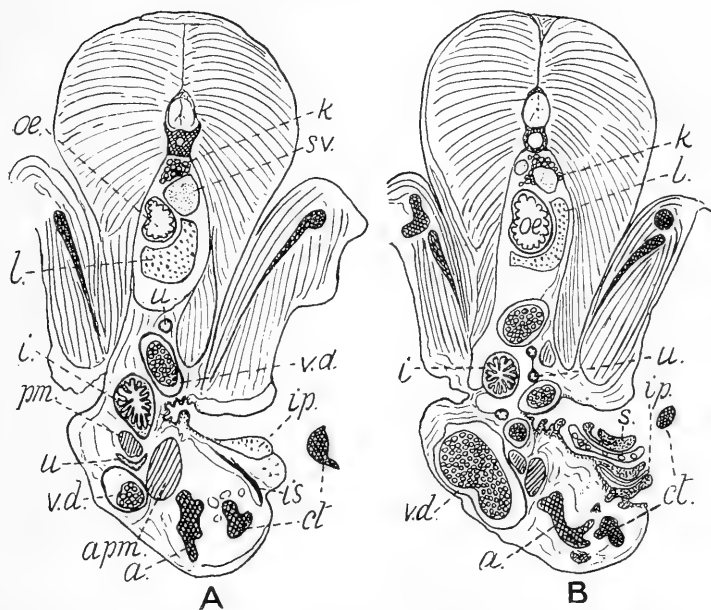
The pulvinular appendage (*pva.*) is subconical, somewhat compressed; it is a mass of parenchymatous cartilage, but has the structure of true hyaline cartilage on the inner side near the base; in this region it is hollowed out for the reception of a cartilaginous peg that arises from a bone in front of it (Pl. II. B).

The pulvinulus consists of fibrous connective tissue surrounding two longitudinal bones, the inner and outer pulvinular bones.

The inner pulvinular bone (*pv.'*) is largest posteriorly, where

it bears a backwardly directed process for the support of the pulvinular appendage; it tapers anteriorly and ends below the axial bone at about the middle of the length of the anterior ridges. This bone is rounded or oval in cross-section, posteriorly deeper than long; it has a cartilaginous core.

Text-figure 5.



Neostethus lankesteri, ♂. Transverse sections cutting the infrasulcar prominence, A, near its anterior end, and B, at its posterior edge, also just cutting the seminal papilla ($\times 18$).

k., kidney; *l.*, liver; *sv.*, sinus venosus; *œ.*, oesophagus; *i.*, intestine; *u.*, ureter; *v.d.*, vas deferens; *pm.*, muscle of proctal side; *apm.*, inner muscle of aproctal side; *s.*, seminal papilla; *ip.*, infrasulcar prominence; *is.*, infrasulcar bone; *a.*, axial bone; *ct.*, ctenactinium.

The outer pulvinular bone (*pv.*) is rather similar to the inner in form and structure (Pl. III. A, *pb.*); posteriorly it bears the pointed antrorse process which appears externally as the pulvinular spine; it runs forwards outside the inner bone, but in front of the end of the latter becomes median and ventral, and extends forwards in front of the end of the axial bone to the extreme anterior end of the priapium.

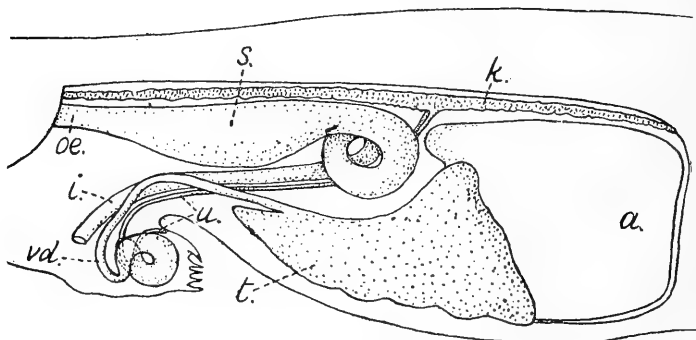
c. VISCERA (text-fig. 6).

Air-bladder (*a.*), alimentary canal, kidneys (*k.*), etc., as in the female, except that the intestine (*i.*) and ureter (*u.*) end in the priapium.

The intestine (*i.*) enters the priapium near the posterior end of its junction with the body (text-fig. 5), and runs downwards, somewhat forwards, and across to the proctal side, ending at the anus.

The ureter (*u.*) enters the priapium just below and behind the intestine (text-fig. 5 B) and runs downwards into the middle of the priapium and across until it meets the enlarged part of the vas deferens, here running backwards on the proctal side; the ureter now runs upwards and backwards and towards the proctal side, always in contact with the vas deferens, and ends by opening into the efferent groove, not far from the proximal end of the latter (text-fig. 7 A).

Text-figure 6.



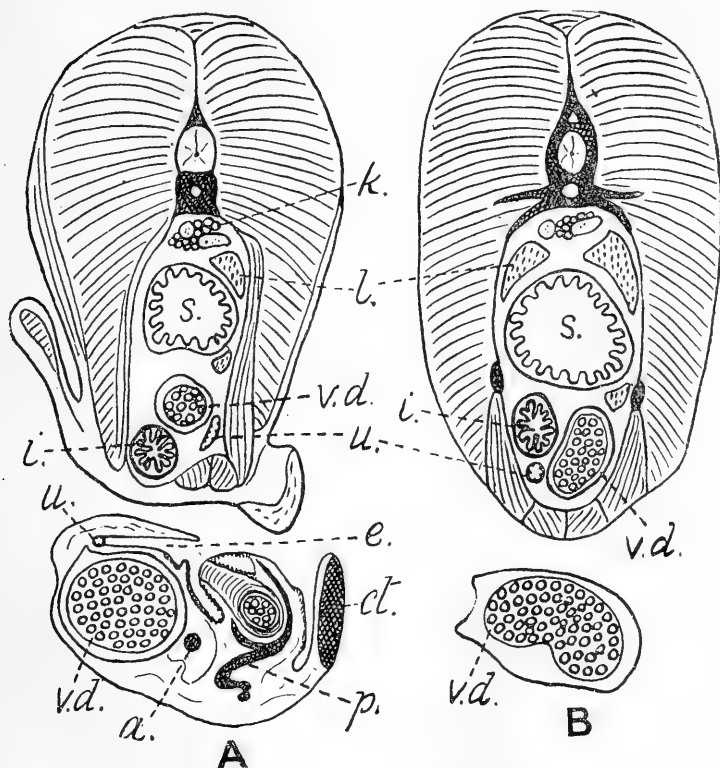
Visceral anatomy of *Neostethus lankesteri*, ♂ (× 8). From the proctal side; the liver, etc., removed.

oe., oesophagus; *s.*, stomach; *i.*, intestine; *k.*, kidney; *u.*, ureter; *t.*, testis; *vd.*, vas deferens; *a.*, air-bladder.

The testis (*t.*) is unpaired (text-fig. 8 A) and corresponds to the ovary in form and position; the vas deferens (*vd.*) arises from the middle of the upper surface of the testis and runs forwards, at first at the side of the intestine and then partly above it; it curves downwards to enter the priapium just behind and on the aproctal side of the intestine, and runs downwards and a little backwards until it reaches the terminal style of the axial bone; the vas deferens runs across to the proctal side below this bone and then expands to form the large terminal coil that runs backwards, then across, and then upwards and forwards, ending in the seminal papilla.

The vas deferens has a thin wall, comprising an outer fibrous layer and an inner layer of mucus-secreting cells; within the testis the tubules that unite to form the vas deferens have a similar structure (Pl. IV. C). The epidermis of the glandular groove also secretes mucus, and in the neighbourhood of the seminal papilla and on the papilla itself the area of secreting-cells is increased by folding.

Text-figure 7.



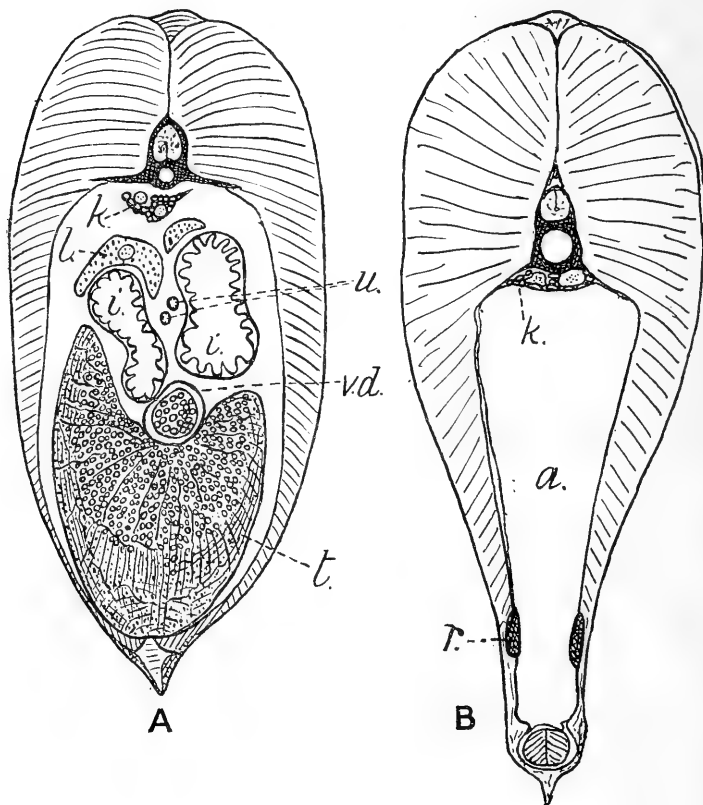
Neostethus lankesteri, ♂. Transverse sections ($\times 18$): A, passing through the posterior part of the seminal papilla, and B, through the priapium near its posterior end.

k., kidney; l., liver; s., stomach; i., intestine; v.d., vas deferens; u., ureter; a., axial bone; p., papillary bone; ct., ctenactinium, e., efferent groove.

The tubules of the testis, the vas deferens, and the glandular groove in the neighbourhood of the seminal papilla hold a mucus secretion, in which appear numerous spermatophores; these are

subspherical, with the heads of the spermatozoa at the periphery and their tails curled round inside (text-fig. 9).

Text-figure 8.



Neostethus lankesteri, ♂. Transverse sections ($\times 18$): A, passing through testis; B, through air-bladder.

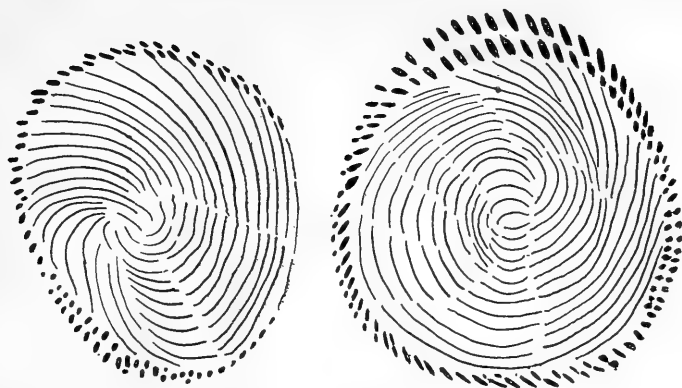
k., kidney; l., liver; i., intestine; t., testis; v.d., vas deferens;
a., air-bladder; r., rib.

Similar spermatophores have been described in the Poeciliinae by Philippi (Philippi, 6), but I have not been able to detect them in other Cyprinodonts.

d. MUSCLES (text-fig. 10).

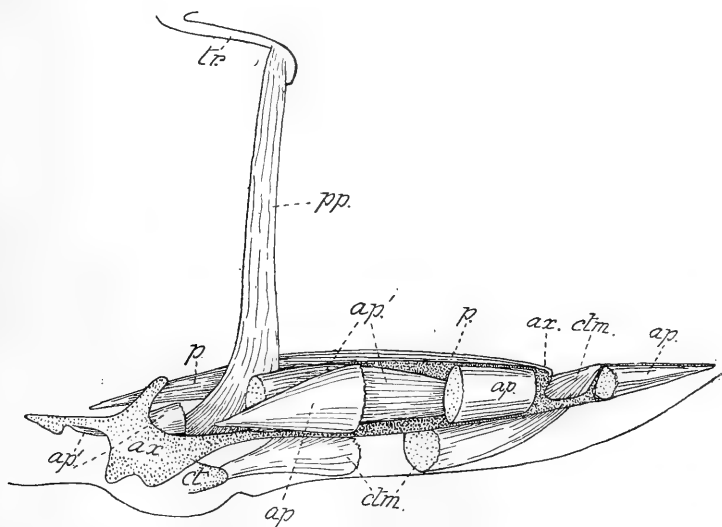
Pleuro-priapial muscle (pp.).—It has been mentioned that the first pair of ribs enter the priapium, and that the rib of the proctal side is much enlarged and is attached proximally to the enlarged

Text-figure 9.

Spermatophores of *Neostethus lankesteri* ($\times 750$).

and forwardly directed transverse process (*tr.*) of the third vertebra. To this process is attached also the proximal end of a muscle that runs downwards into the priapium on the inner side

Text-figure 10.

*Neostethus lankesteri*. Muscles of priapium, from the aproctal side ($\times 20$).

tr., transverse process of third vertebra; *ct.*, base of ctenactinium; *ax.*, axial bone; *pp.*, pleuro-priapial muscle; *p.*, longitudinal muscle of proctal side; *ap.*, outer, and *ap.'*, inner longitudinal muscles of aproctal side; *ctm.*, ctenactinial muscle.

of the rib, and then backwards on the proctal side of the axial bone, ending in a nodule of bone that lies near the axial bone at the level of the articulation of the ctenactinium.

Longitudinal muscles of the priapium.—These are four in number and each is more or less fusiform in shape. In front of the priapial ribs these muscles, with the intermuscular connective tissue and the axial bone, constitute the whole body of the priapium (excluding the pulvinulus) (text-fig. 4 A).

Ctenactinial muscle.—This is the largest of the longitudinal priapial muscles; it originates at the posterior end of the upper anterior ridge of the axial bone and is inserted on the proximal end of the ctenactinium. For most of its length its inner surface lies against the whole proctal face of the main crest and the lower face of the lateral ridge of the axial bone.

Outer muscle of the aproctal side.—This originates at the anterior extremity of the axial bone and runs back on the aproctal side between the anterior ridges of that bone, and then on the aproctal side of the main crest until the inner muscle intervenes; it ends posteriorly at the level of the anus in the connective tissue that lies between the floor of the glandular groove and the lateral ridge of the axial bone.

Inner muscle of the aproctal side.—Anteriorly this is inserted between the outer muscle and the main crest of the axial bone; it runs back in contact with the crest and above the lateral ridge, and then on the aproctal side of the priapial ribs, pleuro-priapial muscle, and intestine; it is attached posteriorly to the lower and proctal surface of the terminal style of the axial bone just above the vas deferens, which is here crossing to the proctal side below the axial bone.

Muscle of the proctal side.—This originates on the anterior end of the upper edge of the main crest of the axial bone, and runs backwards at first above and then at the proctal side of the ctenactinial muscle; it lies on the proctal side of the priapial ribs and intestine and behind them at the side of the inner aproctal muscle; it ends in the connective tissue that lies above the terminal style of the axial bone and between the descending portion and the enlarged terminal part of the vas deferens.

4. *NEOSTETHUS BICORNIS*, sp. n. (text-fig. 11).

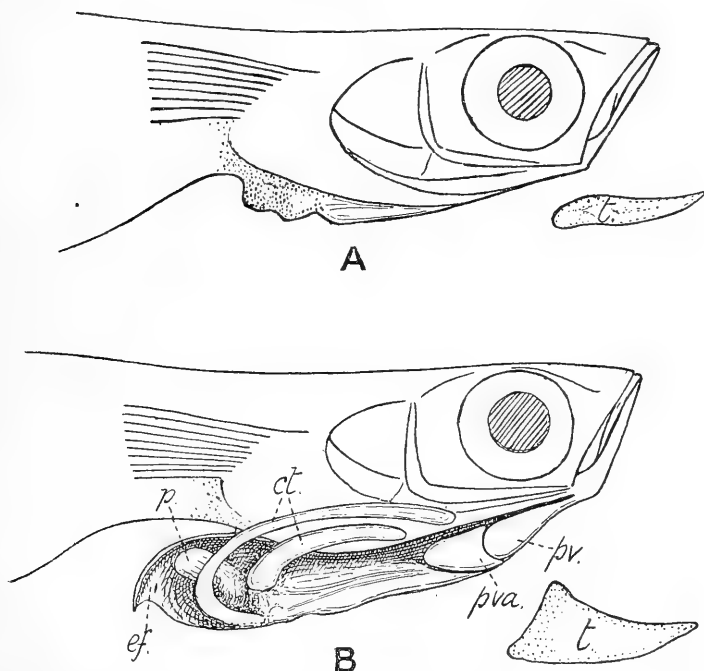
This species is more slender than *N. lankesteri* and has 36 vertebrae (16–17 + 19–20) instead of 34 or 35. There are 13 to 15 anal rays, and 35 to 37 scales in a longitudinal series.

A male of 25 mm. is not fully adult, but its priapium (text-fig. 11, B) differs from that of *N. lankesteri* in three important characters: (1) there are two ctenactinia (*ct.*), both on the aproctal side; (2) the efferent groove (*ef.*) extends downwards to the ventral surface of the posterior end of the priapium; and (3) the seminal papilla (*p.*) opens into the efferent, not the glandular groove. The ctenactinia have not attained their full

development and are cartilaginous and enclosed in skin; their final shape is uncertain; the testis (*t.*) is fairly large.

A male of 21 mm. (text-fig. 11, A) has the priapium but little developed and without trace of ctenactinia, but showing a differentiation into an anterior muscular and a posterior visceral portion; in this fish the testis is quite small.

Text-figure 11.



Neostethus bicornis: immature males; head and priapium from aproctal side ($\times 10$). Total length of fish: A, 21 mm.; B, 25 mm. The testis (*t.*) is shown separately.

pv., pulvinulus; *pva.*, pulvinular appendage; *ct.*, ctenactinia; *p.*, seminal papilla; *ef.*, efferent groove.

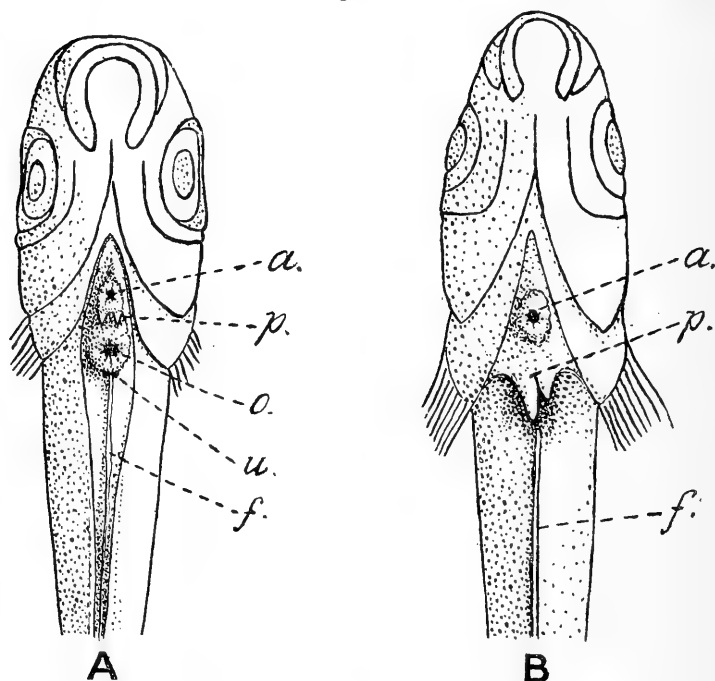
A female of 24 mm. is very similar to the female *N. lankesteri*, except for the more slender form; the postanal depression is less developed than in *N. lankesteri*, probably because the specimen is not fully adult.

The male examples are of interest as indicating that the priapium develops only as maturity approaches; presumably males, only a little smaller than the smaller one, would be almost indistinguishable from immature females.

5. *Structure of Female PHALLOSTETHUS DUNCKERI* *
(text-fig. 12, A).

Total length 29 mm. The mouth is less oblique than in *Neostethus*, and the body is less compressed; the abdominal profile is not convex, but nearly straight, the rayless fringe (*f.*)

Text-figure 12.



A, *Phallostethus dunckeri*, ♀. B, *Neostethus lankesteri*, ♀.

Head and abdomen from below ($\times 8$).

a., anus; *p.*, postanal papillæ (in *Neostethus* covering the depression into which oviduct and ureter open); *o.*, opening of oviduct; *u.*, opening of ureter; *f.*, dermal fold.

lies in a groove instead of at the edge of the abdomen, and the genital opening (*o.*) does not lie in a depression; the postanal papillæ (*p.*) are minute. The dorsal fin has more rays (8 to 10)

* I have already given some account of the structure of *Phallostethus dunckeri* (Regan, 11); the sections of the male fish are too thick and somewhat overstained, but with the much better sections of *Neostethus lankesteri* at hand for comparison I have been able to make out certain details that were difficult to see without this help. So far as I can see, the most important error in my former description was that the pectoral ribs, displaced forward and separated from the vertebral column, were interpreted as elements of the pectoral arch and the antepleural bone, which embraces their ends, was not recognized as a separate bone distinct from them.

than in *Neostethus*, and the anal fin is much longer, having 26 to 28 rays. Correlated with this is the shorter abdominal region, the smaller number of præcaudal vertebræ (11 or 12), and the larger number of caudal vertebræ (26 or 27) (*cf.* Pl. I. A).

The visceral anatomy is as in *Neostethus*.

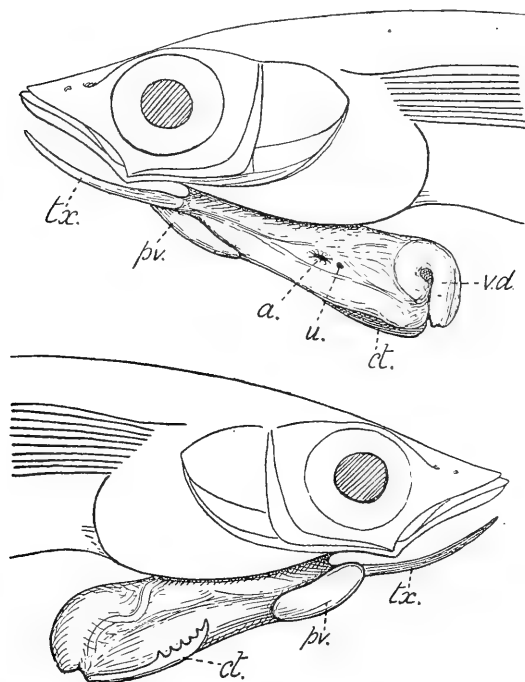
6. *Structure of Male PHALLOSTETHUS DUNCKERI.*

In addition to the differences from *Neostethus* described above for the female, the male *Phallostethus* has many distinctive features.

a. EXTERNAL CHARACTERS.

Total length 25 mm. The priapium (text-fig. 13) is much more prominent than in *Neostethus*; the grooves between it and

Text-figure 13.



Phallostethus dunckeri, ♂. Head and priapium from the proctal and aproctal sides ($\times 10$).

tx., toxactinium; *ct.*, ctenactinium; *pv.*, pulvinulus; *a.*, anus; *u.*, opening of ureter; *vd.*, terminal coil of vas deferens.

the body of the fish are not glandular and are of equal size; they increase in depth posteriorly and meet behind the priapium to

form a median groove; which extends to the anal fin, decreasing in size backwards (text-fig. 15 B); there is no efferent groove.

The urinary opening (*u.*) is immediately behind the anus (*a.*).

The genital opening is ventral and posterior, behind the articulation of the ctenactinium (*ct.*).

The ctenactinium is short and nearly straight, with denticulated upper edge; its articulation is ventral, and it lies on the aproctal side of the priapium.

Anteriorly the attachment of the priapium to the isthmus ends at the level of the posterior edge of the eye; in front of this is a free terminal portion that ends in a second movable bony appendage, toxactinium (*tx.*); this is rounded in cross-section, tapers forwards, and curves towards the aproctal side, ending below the extremity of the lower jaw.

The pulvinulus (*pv.*) appears to be represented by a rounded shield, with thick edges, that covers the basal part of the toxactinium below and on the aproctal side.

b. SKELETON (Pl. I. A).

Third vertebra and first pair of ribs.—The transverse processes of the third vertebra are normal and symmetrical, but bear no ribs. The first pair of ribs are nearly symmetrical, but they are not articulated with the vertebral column; proximally they end at the level of the second vertebra, but at some distance from it on each side; the proximal part of the rib of the proctal side curves forwards to give attachment to the pleuro-priapial muscle. These ribs run downwards and forwards, meet below the pericardium, and enter the priapium, where they run downwards and towards the proctal side in front of the intestine.

Cleithra.—Both cleithra are prolonged forwards and enter the priapium, ending between the pulvinulus and the basal part of the toxactinium (Pl. III. B, *cl.*, *cl.*').

Priapial skeleton.—The axial bone (text-fig. 15, *a.*) is comparatively simple; the toxactinium articulates with its anterior end superiorly and proctally (Pl. III. B, *tx.*, *a.*), the ctenactinium (text-fig. 15, *ct.*) with its posterior end inferiorly and aproctally.

The antepleurale cartilage of *Neostethus* is represented by an antepleurale bone that embraces the distal ends of the priapial ribs and runs forwards on the proctal side of the axial bone, ending a short distance behind the base of the toxactinium.

The pulvinulus has no pulvinular appendage and no bones; it is a ring of parenchymatous cartilage, but seems to have the structure of true hyaline cartilage in the middle (Pl. III. B, *pa.*, *pc.*).

There are no infrapulcar bones, but the terminal part of the *vas deferens* appears to be supported by a bony lamina, as in *Neostethus*.

c. MUSCLES.

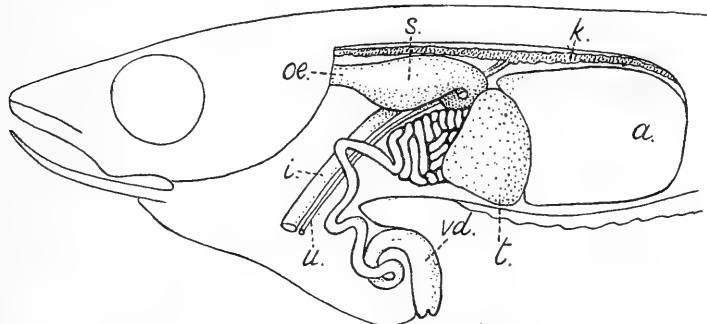
The muscles correspond to those of *Neostethus*, except that (1) the pleuro-priapial muscle is attached proximally to the

proximal part of the first rib of the proctal side instead of to the transverse process of the third vertebra; and (2) there is a toxactinial muscle (text-fig. 15, *tox.*), that lies outside the longitudinal muscle of the proctal side, ends posteriorly between the coils of the vas deferens, and anteriorly is inserted on the base of the toxactinium.

d. VISCERA (text-fig. 14).

A difference from *Neostethus* is that the ureter (*u.*) accompanies the intestine (*i.*) and opens behind the anus; of more importance are differences in the testis and vas deferens (*vd.*). The testis (Pl. IV. A) has no tubules lined with a distinct epithelium, even near the origin of the vas deferens, which leaves the testis (*t.*) anteriorly and at once becomes coiled up into a mass that lies in front of and to the right side of the testis; this "epididymis" is similar to the testis in form and is not much less than it in size

Text-figure 14.



Visceral anatomy of *Phallostethus dunckeri*, ♂; the liver, etc., removed (× 10).

œ., œsophagus; s., stomach; i., intestine; k., kidney; u., ureter; t., testis;
v.d., vas deferens; a., air-bladder.

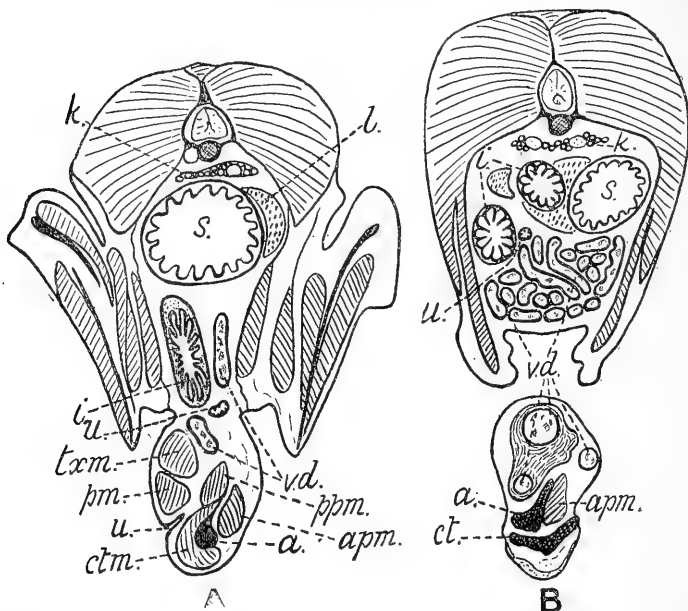
(text-fig. 15, B); the vas deferens emerges from its narrowed anterior end, enters the priapium, and runs backwards on the aproctal side to above the base of the ctenactinium, then across to the proctal side before coiling round in a complete circle and opening ventrally to the exterior in a short seminal papilla behind the base of the ctenactinium.

The vas deferens is lined with a glandular epithelium; in the "epididymis" this is formed of long columnar cells with basal nuclei (Pl. IV. B). The outer fibrous layer is quite thin, except in the terminal coil, where it is thick. The lumen contains spermatozoa, which seem to adhere together, their heads forming more or less convex plates, whilst their tails are dependent from the concave surfaces. However, this structure cannot be very definitely made out from the sections, but it seems clear that there are no spermatophores of the type described in *Neostethus*.

7. *Remarks on the Structure of the Priapium.*

Many of the peculiarities of the priapium of *Phallostethus*, as compared with that of *Neostethus*, seem connected with the two main differences, that the vas deferens opens directly to the exterior instead of into a glandular groove and that a tox-actinium is present. To the absence of a glandular groove may be due the great length of the vas deferens, which coils to form an "epididymis"; the secretion supplied in *Neostethus* by the testis,

Text-figure 15.



Phallostethus dunckeri, ♂. Transverse sections ($\times 18$): A, showing the intestine, vas deferens, and ureter entering the priapium, and also the ureter opening to the exterior; B, showing the "epididymis" and the posterior thick-walled portion of the vas deferens above the articulation of the ctenactinium.

k., kidney; l., liver; s., stomach; i., intestine; u., ureter; v.d., vas deferens; a., axial bone; ct., ctenactinium; p.p.m., pleuro-priapial muscle; t.x.m., tox-actinial muscle; c.t.m., ctenactinial muscle; p.m., muscle of the proctal side; a.p.m., inner muscle of the aprectal side.

the vas deferens, and the glandular groove comes in *Phallostethus* from the vas deferens alone. The efferent groove, infrasulcar bones, and pulvinular appendage of *Neostethus* are all directly connected with the glandular groove, and it is not surprising that they are absent in *Phallostethus*.

The approximate symmetry of the priapial ribs and cleithra in *Phallostethus*, as compared with their marked asymmetry in *Neostethus*, is no doubt due to the symmetrical attachment of the priapium in the former (text-fig. 15), and its asymmetrical attachment, owing to the great development of the glandular groove, in the latter (text-fig. 4).

With the presence of a toxactinium as a free appendage may be correlated the freedom of the anterior part of the priapium in *Phallostethus*, whereas in *Neostethus* it is attached to the isthmus right to the end. It seems probable that the toxactinium may replace functionally the anterior part of the ctenactinium of *Neostethus*, and that the shortness of the ctenactinium of *Phallostethus* may be connected with this.

In both genera the ureter enters the priapium and runs downwards and across to the proctal side behind the intestine; in *Phallostethus* it opens to the exterior just behind the anus, but in *Neostethus*, owing to the shortness of the free posterior part of the priapium and the great size of the terminal coil of the vas deferens, it finds the latter in its way and has to surmount it before reaching the surface at some distance from the anus.

In *Phallostethus*, as compared with *Neostethus*, the great length and coiling of the vas deferens, the separation of the first pair of ribs from the vertebral column, and perhaps the presence of a toxactinium, may be features of specialization; in *Neostethus* the development of the glandular groove and the structures associated with it may be similarly regarded.

When I first described *Phallostethus* I suggested that the axial bone of the priapium might be pelvic and the ctenactinium and toxactinium fin-rays. This interpretation seems much less likely to be correct when the structure of *Neostethus* is considered also. The antepulchral cartilage of *Neostethus* has developed in *Phallostethus* into a long bone with a cartilaginous core; conversely, the presence in *Neostethus* of pulvinular and infrasulcar bones, absent from *Phallostethus*, seems to show that the skeletal elements of the priapium develop when and where they are wanted, and are not to be homologized with any other parts of the skeleton. Moreover, the pulvinular appendage of *Neostethus* seems to represent a stage of development intermediate between a simple dermal papilla and movable bony appendages, such as the ctenactinium and toxactinium, and suggests that these may have originated as outgrowths whose skeleton changed from connective tissue to cartilage and then to bone as they grew longer and formed more definite proximal articulations with the axial bone. Their development in *Neostethus bicornis* supports this view.

In fact, the whole priapium seems to be an entirely new formation; its appendages, bones, muscles, and glands are not to be homologized with any structures found in the female fish or in other Cyprinodonts.

8. *Use of the Priapium.*

In oviparous Cyprinodonts (*Fundulus* and *Cyprinodon*), Newman (5) has observed the intercourse of the sexes; the male and female lie side by side and looking in the same direction, and the male clasps his mate by folding his dorsal and anal fins across her, whilst the paired fins also may interlock; in this way the eggs and sperm are extruded in such close proximity that fertilization is assured.

It seems likely that in the Phallostethinae also the male and female take up a similar position, the female lying on the aproctal side of her mate.

In *Phallostethus* the toxactinium, which curves towards the aproctal side, may grip her under the chin or even be held in her mouth, whilst the serrated edge of the ctenactinium may give it a firm hold on the pectoral region in front of and on the far side of the genital orifice, in order that the seminal papilla may be placed against or introduced into the latter.

In *Neostethus* it seems likely that during intercourse the female may be held by the ctenactinium across the back of the head, the anterior descending part lying on her distal side and the terminal part that at rest curves across under the chin of the male now curving towards him, perhaps under hers. The spinous process of the ctenactinium and the pulvinular spine would stick into her on the side near the male. The posterior end of the priapium may be held in the depression into which the oviduct opens, whilst the terminal projecting part of the fold that roofs the efferent groove and the membranous fringe below it may form a sort of tube for insertion into the genital aperture of the female.

The asymmetry of the postanal papillae of the female may be due to the side by side position presumably adopted; if so, it may be supposed that a male with the right side aproctal would pair with a female that had the smaller papilla on the left side, and *vice versa*.

It is possible that no part of the priapium is actually introduced into the oviduct, and that the spermatophores, first discharged into the glandular groove and then ejected through the efferent groove, may adhere to the surface of the postanal papillae and of the depression into which the oviduct opens, and that they may be introduced into the oviduct by the action of the papillae.

The infrasulcar prominence may prevent the flow of the seminal fluid outwards or forwards at the place where it exerts the greatest pressure, and the pulvinular appendage may possibly help to drive the glandular secretion backwards.

In both *Phallostethus* and *Neostethus* the probable effect of the contraction of the longitudinal muscles of the aproctal side and of the pleuro-priapial muscle would be to move the posterior end of the priapium aproctally; an additional effect in *Neostethus* would be to close the glandular groove.

It is only by a study of the actual behaviour of these fishes during the breeding-season that one can hope fully to understand the purpose for which this elaborate apparatus has been evolved.

9. *Comparison of the Priapium with other Copulatory Organs of Fishes.*

In many bony fishes a papilla bearing the genital aperture forms a simple but efficient intromittent organ; in others the anal fin is utilized, the vas deferens either opening at its base or being prolonged on the fin, which may form a copulatory organ of considerable complexity of structure, as in the viviparous Cyprinodonts, Pœciliinæ, Anablepinæ, etc. (Regan, 10; Garman, 1; Langer, 4).

In its asymmetry and in being either dextral or sinistral the priapium agrees with the copulatory organ of *Anableps* (Garman, 1).

In the Phallostethinæ the remoteness of the genital opening from the anal fin explains why the latter has not been involved, but does not explain the extraordinary complexity of the priapium, which parallels the mixopterygia of the Selachians in its specialized skeletal and muscular system (Jungersen, 3).

In the mixopterygia new skeletal elements are developed, and may either margin a groove or may become movably articulated with the main axial piece; one may project as an external spine, in this case formed of calcified cartilage, not of bone. Another parallel with the priapium is that the mixopterygia attain their full development rapidly as the individual becomes sexually mature.

In the Selachians the mixopterygium has a nearly uniform structure in members of the same family, or even of the same suborder (Huber, 2; Regan 7), and the differences between the priapia of *Phallostethus* and *Neostethus* are as great as between the mixopterygia of the subclasses Holocephali and Euselachii.

10. *Rank and Position of the Phallostethinæ.*

There can be little doubt but that *Neostethus* and *Phallostethus* belong to the family Cyprinodontidæ, and they seem to agree in every way with the most generalized subfamily, the Fundulinæ, except for three features of specialization, namely, the anterior position of the anus, the absence of pelvic fins, and the development of a priapium in the male. This view as to their relationship is best expressed by placing them in a distinct subfamily, Phallostethinæ, of the Cyprinodontidæ, a family that already includes both oviparous and viviparous fishes, the latter with intromittent organs of three different types (Regan, 8).

Other examples of animals which retain the general structure of the group to which they belong, whilst one particular organ or system is profoundly modified or some new feature of importance

is developed, can readily be found, although few cases are so striking as the *Phallostethinæ*.

Among fishes, one may recall the curious Cyprinid *Gyrinochilus* (Regan, 9, p. 29), which has the form, fins, scales, etc., of *Crossochilus* and *Discognathus*, to which it is certainly closely related, yet it has the mouth, gills, and pharyngeals so modified in connection with its peculiar methods of breathing and feeding that some ichthyologists have regarded it as the type of a separate family.

Because *Neostethus* and *Phallostethus* so obviously belong to the large and varied family Cyprinodontidæ, one attaches but little classificatory importance to the development of the priapium and its evolution along two very distinct lines. But if these were the only known Cyprinodonts they would certainly form a separate order, and the differences in structure of the priapia would be regarded not merely as generic, but as subordinal, and the much longer anal fin, the abdominal groove, etc., of *Phallostethus* would be held to support the view derived from the structure of the priapia that it and *Neostethus* had diverged widely and through a long period of time from their common ancestor.

Were these the only living Teleosts many zoologists would regard them as a separate class, comprising two well-marked orders, just as some have suggested that the Dipnoans should be removed from the Pisces, mainly on account of the isolated position of their living representatives, *Ceratodus* and the Lepidosirenidæ, and have given these ordinal rank with the names Monopneumones and Dipneumones.

These somewhat fanciful considerations are put forward merely to suggest that the rank given to a group depends on several factors, and that the degree of differentiation is one of the least of these.

11. *Note on the Origin and Homologies of Skeletal Elements.*

The priapium appears to be an entirely new organ, and it has a highly developed skeleton, comprising a number of new elements that cannot be homologized with any parts of the skeleton of other fishes; this suggests that the intermuscular connective-tissue may give rise to cartilaginous or bony elements whenever and wherever the necessity may arise. This is, of course, not new, but it is a point of view not always kept in mind by morphologists, as could be illustrated by numerous examples, one of which may be adduced.

In certain Selachians, and especially in the Hypotremata, there is a median series of vertical cartilaginous plates above the vertebral column, and the question has been raised whether these belong to the vertebral column or to the fin-skeleton. Thus Goodrich (Lankester's 'Treatise of Zoology,' pt. ix. figs. 50, 52) has figured them in *Squalus* and *Squatina*, and has described them as either modified radials or neural spines. I have long thought it probable that they were neither, but autogenous

structures developed in the intermuscular septum, and I feel this opinion strengthened as the result of my work on the Phallostethinæ.

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EXPLANATION OF THE PLATES.

PLATE I.

Skeletons of *Phallostethus dunckeri* (A) and *Neostethus lankesteri* (B), reconstructed; A 6 and B 5 times the actual size.

PLATE II.

Neostethus lankesteri.

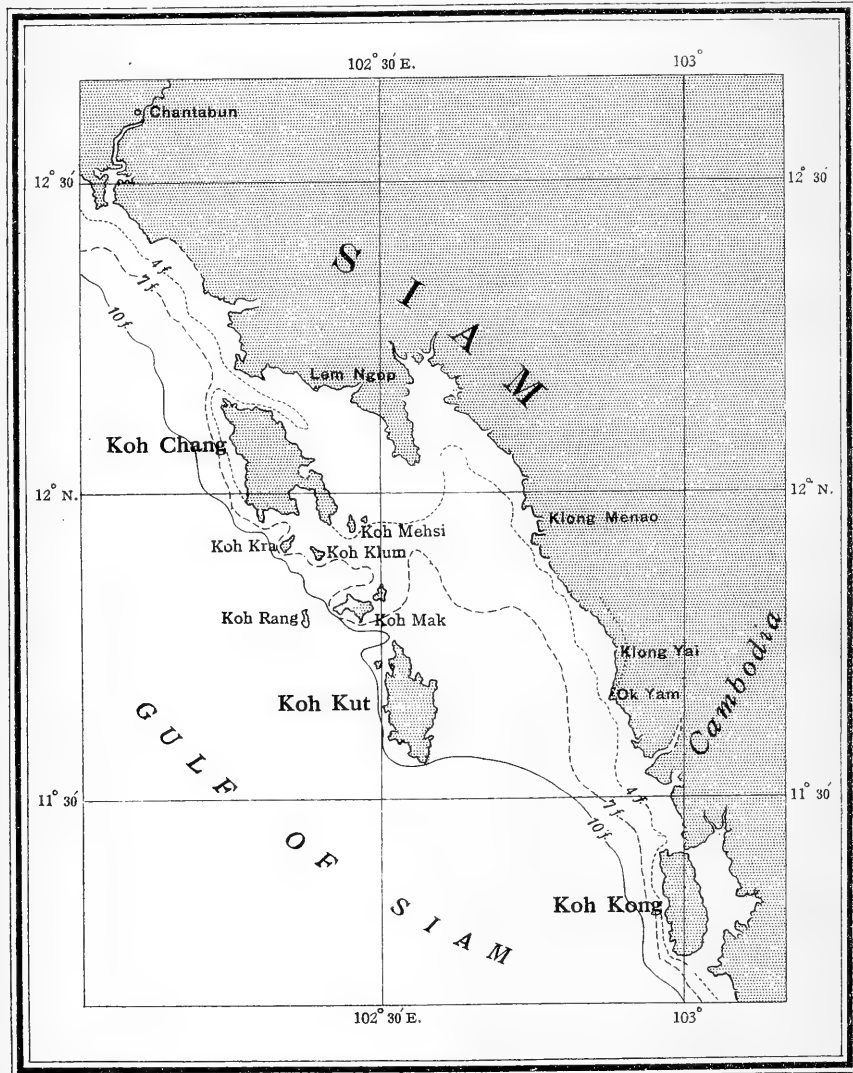
- A. Transverse section through anterior part of seminal papilla and adjacent portion of glandular groove (× 130). *e.*, glandular epidermis lining folds and pockets on surface of papilla; *p.*, papillary bone; *sp.*, mass of mucus containing spermatophores, lying in the vas deferens, where this opens into the glandular groove (*g.*); *a.*, process of axial bone.
- B. Transverse section through glandular groove and pulvinulus at base of pulvinular appendage (× 130). *g.*, glandular groove; *i.*, infrapulvinular groove; *is.*, anterior infrascler bone; *pvb.*, cartilaginous terminal process of inner pulvinular bone, for articulation of pulvinular appendage (*pva.*).

PLATE III.

- A. *Neostethus lankesteri*. Transverse section through isthmus and anterior part of priapium ($\times 130$); the right side is aproctal. *u.*, urohyal; *cl.*, cleithrum of aproctal side; *a.*, axial bone; *pb.*, outer pulvinular bone; *g.*, glandular epidermis; *m.*, outer muscle of aproctal side.
- B. *Phallostethus dunckeri*. Transverse section through isthmus and anterior part of priapium, showing the toxactinium articulating with the axial bone ($\times 130$); the left side is aproctal. *u.*, urohyal; *a.*, axial bone; *tx.*, toxactinium; *cl.*, *cl.*', cleithra; *pc.*, pulvinular cartilage; *pa.*, parenchymatous cartilage.

PLATE IV.

- A. *Phallostethus dunckeri*. Transverse section through part of testis near origin of vas deferens ($\times 200$).
- B. *Phallostethus dunckeri*. Transverse section through "epididymis" ($\times 170$).
- C. *Neostethus lankesteri*. Transverse section through upper part of testis ($\times 170$).



Reg. No. 231-15.

Scale, 21 Miles to an Inch

Drawn at the C.D.O. K.L. F.M.S.

Miles 10 5 0 10 20 30 40 Miles

SKETCH MAP OF S.E. SIAM

2. On a Collection of Mammals from the Coast and Islands of South-East Siam. By C. BODEN KLOSS, F.Z.S., F.R.G.S. With an Account of the Fruit-Bats, by Dr. KNUD ANDERSEN, F.Z.S.

[Received August 30, 1915: Read November 9, 1915.]

(Plate I.* and Text-figures 1, 2.)

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Towards the end of 1914 I went on short leave to Siam with three Dyak assistants, my object being zoological collecting in the extreme south-east of the country, and having reached Chantabun by steamer *via* Bangkok, I hired a small native sailing-vessel ("rua pet") and passed six weeks cruising and camping on the coast and islands beyond (see Pl. I.), getting in altogether about thirty-three working days. The result was a set of rather over 500 mammals, 300 birds, and 250 reptiles and batrachians.

Mammals were the principal object of the excursion, and I chose this district of the mainland because very little investigation of it had taken place, while the islands were quite untouched; for although Captain Stanley Flower appears to have been in Chantabun in 1898 (P. Z. S. 1900), no other naturalist has followed Mouhot, whose collections were reported on by Gray and Günther in the 'Proceedings' of 1859 and 1861.

In recent years Mr. T. H. Lyle has sent home specimens

* For explanation of the Plate see p. 66.

from the better-known parts of Siam—the basin of the Menam and its head-waters near Chiengmai and Nan (*cf.* Bonhote, P. Z. S. 1900, 1901, 1902); and the ornithologist Count Nils Gyldenstolpe, of the Royal Swedish Museum, has lately collected mammals in much the same area and also in the province of Korat (*cf.* Gyldenstolpe, *Arkiv för Zoologi*, Stockholm, 1914); but still the remote south-east has remained unvisited, nor can I find that its French possessors have carried out any investigations in the adjacent parts of Cambodia. So to the zoologist the region between Cochin-China and the better-known districts of Siam was largely a no-man's-land.

The mainland visited requires no description; it is undulating coastal country, covered with forest except round villages, and with mountains in the distance. Lem Ngop* lies on the north shore of Koh Chang† Strait, and Ok Yam (or Jam) is eastward of Koh Kut, just within French territory, as the present boundary of Cambodia comes out on the coast half a mile to the west of it (lat. 11° 40' N.). Klong Yai‡ and Klong Menao are estuaries to the north of Ok Yam.

Of the islands, Koh Chang is about 15 miles long and 7 wide; it is very hilly, and its highest peak, one of a number, rises to 2446 ft. The strait which separates it from the mainland narrows in part to 3 miles, though, since much of the adjoining province is an alluvial plain, the island was probably at one time more isolated. It is the northernmost of the Chantabun Archipelago.

The two little islands of Mehsi (935 ft. high) lie close together, two miles off the south-east end of Koh Chang; they are called on the chart (Admiralty 2721) "Ile du Pic" and "Le Chameau" respectively. A little farther from the southern shore lie Koh Klun (600 ft.) and Koh Kra (800 ft.).

Koh Kut, 15 miles S.S.E. of Koh Chang and about 18 miles from the Siamese-Cambodian coast, is the southernmost of the group; it is some 13 miles long and 5 wide, elevated, with a peak of 1171 ft. It is uninhabited, but swarms with ticks, which infest every animal upon it and made our week's residence there a most uncomfortable experience.

Between the northern islands and Koh Kut, from east to west, are Koh Mak and Koh Rang (800 ft.), the first the larger, being about 4 miles long, but, except for one small hill, very low. Three miles or so west of it is Koh Rang (Koh Loi of the chart), the most seaward of the group, and, like the other smaller islands, a little under two miles long. There are, further, a few little islets which I did not visit.

Koh Chang and the Mehsi Islands are separated from the mainland by depths of between 3 and 4 fathoms; Kra, Klun, and Mak rise from 6 to 7 fathoms of water; Koh Kut stands in 9 to 10 fathoms, and Koh Rang is on the 12-fathom contour-

* Lem=Cape.

† Koh=Island.

‡ Klong=River.

line. All are covered with dense evergreen tropical forest, and Koh Chang and Koh Mak alone are inhabited.

The only terrestrial mammals on the smaller islands are forms of *Epimys surifer* and *E. rattus*. Koh Mehsi, though nearer the mainland, higher, and in shallower water, has a form of the latter only.

Koh Chang and Koh Kut vary in the composition of their faunas, for while the former lacks a *Ratufa*, a species which occurs on Koh Kut, the latter is without any *Presbytis*, *Tupaia*, or *rattus* rat, all of which are found on the larger island. On both a form of *Epimys jerdoni* is very common, though it was not met with on the mainland.

When we got back to Bangkok visits were paid to Koh Si and Koh Phai in the Inner Gulf, and accounts of the collections made on them and of the reptiles and batrachians obtained in the south-east appear in the 'Journal' of the Natural History Society of Siam, while a report on the birds is contributed to 'The Ibis.'

The first set of all collections has been given to the British Museum (Nat. Hist.) at South Kensington, and the second to the U.S. National Museum at Washington.

Ridgway's colour-names used here are those of his second publication, 'Colour Standards and Nomenclature,' 1912

Though in the title of this paper I have mentioned only one locality for the sake of brevity, it may be said that most of the specimens obtained at Ok Yam and many from Klong Yai actually came from the Cambodian side of the boundary, as it now runs between Siam and that country.

1. HYLOBATES PILEATUS Gray.

Hylobates pileatus Gray, P. Z. S. 1861, p. 135, pl. xxi.; de Pou-sargues, Mission Pavie, Indo-Chine, Études Diverses, iii. p. 511 et seq. (1904).

Hylobates agilis, variety *pileatus* Flower, P. Z. S. 1900, p. 313.

5 adult males, 2 adult females, 1 female juv., from Klong Menao and Len Ngop, S.E. Siam.

It is probable that these animals are practically topotypes, as Mouhot's specimens came from some part of Cambodia. The statement that they were met with on a small island near the coast must be received with hesitation until their occurrence in an insular locality is confirmed.

The original description of the species applies excellently to the present series of this individually variable genus. The five males are (though paler on the dorsal region and the lower half of the legs) black or brownish black throughout except for a ring round the face, the hands and feet, and a genital tuft, which are dull white or buffy-white. The pale band running from the temples round the back of the head, greyish, ashy or brownish posteriorly, is not always complete behind, and then the dark

patch on the crown (which gives its name to the species) is not always isolated. The pale area on the hands and feet varies in extent; sometimes it covers the extremities from the wrists and ankles and sometimes is confined to the fingers and toes.

The two adult females are drab above, the rump and outer side of limbs somewhat warmer in tone, being slightly tinged with ochraceous. The crown, cheeks, throat, and a diamond- or shield-shaped area over the breast and abdomen extending to the axillæ and almost to the genital region are blackish. The hands and feet, inner side of limbs, and the pelage bordering the black areas are somewhat lighter than the rest of the body.

The young female is drab to buffy throughout except for a slightly indicated dark cap on the top of the head.

Gray was only able to state that the pale examples examined by him were "probably female." I was told by Siamese villagers who saw my specimens that females were always pale on the back and limbs, while the abdominal surface is variable (*cf.* de Pousargues, *op. cit.* p. 516).

I am of opinion that this animal should be given only sub-specific rank and treated as a geographical race of *H. lar*, which occurs as far east as Luang Prabang (de Pousargues, *op. cit.* p. 511) and in Central Siam, east of the Menam (Gyldenstolpe, *Arkiv för Zoologi*, Band 8, no. 23, p. 6, 1914).

Though I only obtained these animals at two collecting-stations, we heard them calling every morning from the hills all along the coast from Ok Yam on the Franco-Siamese boundary to the mouth of the Ban Yao River near Chantabun. Their cry did not appear to differ in any way from that of *H. lar* or *H. agilis*.

Measurements.—See table, p. 67.

2. *MACACA ANDAMANENSIS* Bartlett.

Macaca andamanensis Bartlett, Land and Water, vol. viii. p. 57 (1869); Sclater, P. Z. S. 1869, p. 467 & figure.

Macaca leoninus Sclater, P. Z. S. 1870, p. 663, pl. xxxv.; *id.*, *op. cit.* 1898, p. 280; de Pousargues, Mission Pavie, Indo-Chine, Études Diverses, iii. p. 517 (1904).

A single adult female of this species was obtained at Klong Menao. This sex does not appear to have been fully described, so that an account of the present specimen may not be out of place.

Colour.—Crown, nape, and entire upper surface, outer side of forearms, hands, and feet mummy-brown to olive-brown, slightly lighter and yellower across the shoulders and lighter on the upper part of forearms and on the sides, the hairs annulated with dull pale buff. Thighs and buttocks paler and greyer (near drab-grey), devoid of annulations, the hips somewhat more buffy. Face, temples, sides of head and neck, and buttocks buffy-silvery or dirty brownish white, underside of body and inner side of arms more silvery. Tail mummy-brown below, blackish brown

above, this colour not continued on to the rump, which is scarcely perceptibly darkened mesially. Inner side of ears silvery, a few dark hairs round the eyes. Skin of orbital region in living animal pale lilac-blue; nose, lips, palms, and soles fleshy brown.

Comparison with females of *M. nemestrina* from the Malay Peninsula shows that the female *andamanensis* differs in the absence of any rufous or ochraceous tone in the pelage and in its undarkened rump: while, as regards the skull, the muzzle is much reduced in size and tapers both upwards and forwards and the interpterygoid space is wider, embracing laterally a greater portion of the bullæ.

Considering the individual variability of macaques, the dimensions of the skull are in strikingly close agreement with those of the female recorded by Anderson in 'Zoological Researches,' p. 52, which probably came from the country west of the Irawadi River.

Measurements.—External measurements, taken in the flesh: total length, 640 mm.; tail from angle formed with rump above, 200; head to vent, 480; hind foot, 158; ear, 38. Skull: greatest length, 117·5 (113·8); basal length, 77·7 (79·2); palate to foramen magnum, 32 (34·5); anterior edge of auditory opening to gnathion, 86·2 (81·2); occiput to narion, 85 (87·6); narion to gnathion, 49·3 (51·7); orbit to gnathion, 39; breadth of muzzle at pm¹ 30·5 (30·4), at m³ 35·6 (34·3), at roots of zygomata 40; facial breadth at fronto-malar suture, 61 (62); post-orbital breadth, 47·6 (48·2); zygomatic breadth, 77 (76); mastoid breadth, 64 (62·7); orbit, 25 × 25·5 (24 × 28); maxillary tooth-row exclusive of incisors, 38; length of mandible in alveolar plane, 77 (75).

Elliot has pointed out ('Review of the Primates,' vol. ii. p. 209) that Blyth's name for this monkey is preoccupied by *leonina* Shaw, applied to *M. albibarbatus*, so that *andamanensis* Bartlett, based on an example introduced into the Andamans from Burma, must unfortunately be used.

3. MACACA IRUS Cuvier.

Macacus irus F. Cuv. Mém. Mus. Hist. Nat. Paris, iv. 1818, p. 120.

Macacus cynomolgus Flower, P. Z. S. 1900, p. 316; de Pou-sargues, Mission Pavie, Indo-Chine, Études Diverses, iii. p. 517 (1904).

Pithecus fascicularis Gyldenstolpe, Arkiv för Zoologi, Band 8, No. 23, p. 3 (1914).

3 adult males, 2 adult females, 1 immature female, from Koh Kut Id., S.E. Siam.

3 immature females, from Koh Chang Id., S.E. Siam.

I have compared these animals with a large number from the Malay Peninsula and adjacent islands which show a great

amount of individual variation from each locality. The only difference I can detect is that, series for series, the Siamese animals have perhaps a somewhat greater quantity of black hairs on the forehead and top of head, but the distinction is unimportant, and I have therefore placed them under the name first definitely applied to the crab-eating monkey of the S.E. Asiatic mainland.

It may be said that the blackish hands and feet which Elliot ('Review of the Primates,' vol. ii. pp. 189, 230, 231, 233 (1913)) emphasizes as the distinguishing characters of *M. irus* do not, so far as my experience goes, exist.

On the whole the series is very uniform, save that adult females have no trace of rufous on the dorsal surface.

We met with a large herd of these monkeys on the mainland on one occasion while sailing up a river at daybreak, but were not prepared for obtaining them.

Measurements.—See table, p. 67.

4. PRESBYTIS GERMAINI M.-E.

Semnopithecus germani Milne-Edwards, Bull. Soc. Philom. 1876, Feb. 12; Flower, P. Z. S. 1900, p. 319; de Pousargues, Mission Pavie, Indo-Chine, Études Diverses, iii. p. 517 (1904) (mis-spelt *germani*).

Presbytis germani Gyldenstolpe, Arkiv för Zoologi, Stockholm, Band 8, No. 23, p. 5 (1914).

One adult male of this handsome silvery-black leaf-monkey was obtained at Klong Yai, S.E. Siam, where, and in Cambodia and Cochinchina, it is the representative of the *cristata* group.

Measurements.—See table, p. 67; and also under *P. g. mandibularis*.

5. PRESBYTIS GERMAINI MANDIBULARIS, subsp. n.

Type. Adult male (skin and skull), No. 1433/C.B.K. B.M. No. 15.11.4.5. Collected on Koh Chang Id., S.E. Siam, 7th December, 1914.

Characters.—A form of *P. germani* characterised by smaller size, paler legs, more slender zygomata, broader interpterygoid space and basioccipital, and by the higher and narrower ascending ramus of the mandible.

Colour.—Resembles *P. germani*, except that whereas in the mainland animal the buttocks, outer and posterior sides of legs are pure silvery white, sharply contrasting with the black feet and back, in the island form these areas are black or greyish, only frosted with silver, and thus less contrasting with the feet and back.

Skull and Teeth.—As compared with an adult but less aged male from the mainland, the skull is smaller; the zygomatic arches much less deep (4:7 mm.), the lower edge being concave instead of straight; the basioccipital is relatively broader; the interpterygoid space broader and more oblique, the sides more spread

out, and the tips of the pterygoids farther apart (36 : 33 mm.). The ascending ramus of the mandible is steeper, being both higher and narrower, with the sigmoid notch less broad; a line passing down the back of the condyle and angle of the mandible is almost perpendicular to the plane of the base of the mandible in *P. germaini*, while in its subspecies, at their junction, these planes form an acute angle only.

*Measurements**.—External measurements, taken in the flesh: total length, 1260 (1300) mm.; tail from angle formed with rump above, 720 (755); head to vent, 540 (570); hind foot, 160 (160); ear, 40 (42). Skull: greatest length, 99·5 (106); basal length, 72·5 (80); zygomatic breadth, 77 (78); maxillary tooth-row, 35 (36); greatest length of mandible, 73 (81): perpendicular height of coronoid process, 47 (44); perpendicular height of condyle, 44 (42); breadth of ascending ramus from anterior root opposite centre of m_2 to angle, 32 (34); coronoid process to back of condyle mesially, 16 (18·5).

Specimens examined.—Seven (the type, 3 adult females, 2 immature females, 1 male juv.)†.

Remarks.—Though, as listed above, I have only one adult male from the mainland for comparative purposes, I have regarded it as a typical example, and while the above details record differences between it and the insular male, the characters of the latter are completely confirmed by the remainder of the series from Koh Chang.

The colour of the infant male is ochraceous orange above, ochraceous buff below, with traces of darkening on forehead, temples, and tip of tail.

The two immature females, both partially retaining their milk-dentition, resemble adults in every respect in colour of pelage. No form of *Presbytis* occurs on the neighbouring large island, Koh Kut.

6. PARADOXURUS HERMAPHRODITUS Pall.

Viverra hermaphrodita Pallas, Schreber, Säugeth. iii. p. 426 (1778).

Paradoxurus pallasii Gray, P. Z. S. 1861, p. 136.

Paradoxurus hermaphroditus Flower, P. Z. S. 1900, p. 329; de Pousargues, Mission Pavie, Indo-Chine, Études Diverses, iii. p. 522 (1904).

A half-grown female was obtained on Koh Chang Id. which differs from *P. m. kutensis* in its lighter, more buffy colour, narrower stripes, and paler shoulders; the muzzle and extremities are less black, and the chest is darker; a broad pale band extends uninterruptedly across the forehead, much reducing the brownish area on the top of the head. Save for this latter, it appears to bear some likeness to *P. cochinchensis* of Cochin-China (Schwarz,

* Measurements in parentheses those of an adult male from the adjacent mainland, No. 1839/C.B.K.

† See table, p. 67.

Ann. & Mag. Nat. Hist. ser. 8, vol. vii. p. 635, 1911), but it also exactly resembles externally a specimen from the State of Perlis, in the Malay Peninsula, and others from islands north of Penang. The skull is too young for comparison.

7. *PARADOXURUS MINOR KUTENSIS*, subsp. n.

Type. Adult male (skin and skull), No. 1749/C.B.K. B.M. No. 15.11.4.39. Collected on Koh Kut Id., S.E. Siam, 27th December, 1914.

Characters.—A race of *P. minor* Bonhote ('Fasciculi Malayenses,' Zoology, Part 1, p. 9, 1903), characterised by blacker (less brownish) muzzle, crown, tail, and extremities, less fulvous fur above, paler nape and chest, the latter concolorous with the rest of the buffy abdomen, by the great breadth across the zygomata, and by smaller bullæ.

Colour.—Muzzle, chin and throat, top of head and ears, distal half of fore and hind limbs extending higher on under surface, and greater part of tail brownish black. Five black stripes or rows of spots on the back and a few on the flanks, the inner three extending on to the base of the tail and becoming somewhat broken and irregular on the shoulders, which, with the neck, are somewhat clouded with blackish. A few black spots on sides and thighs. General ground-colour of the body, extending to the throat below and over the neck above, pale smoke-grey, slightly tinged with buff on the rump and thighs. A broad whitish band from above the eyes passes below the ears to the sides of the neck, but is interrupted on the forehead, where the black area of the muzzle is connected with that of the crown. Base of tail pale fulvous clouded with longer black-tipped hairs.

Skull and Teeth.—The skull agrees with those of *P. minor*, from Peninsular Siam, but is rather larger, the zygomatic breadth in particular being greater. The bullæ, on the other hand, are considerably smaller. The teeth also are in general agreement, but there is a greater deflection in the maxillary row owing to the fact that the posterior cusp of m^1 is placed much nearer the centre of that tooth.

Measurements *.—External measurements, taken in the flesh : total length, 480 (460) mm.; tail, 420 (450); hind foot, 74 (64); ear, 40 (39). Skull : greatest length, 101 (96); basal length, 90; length of palate, 45 (43); breadth of palate between carnassials, 16 (14); greatest breadth of brain-case, 35.5 (32); zygomatic breadth, 58.5 (53); intertemporal constriction, 13; length of maxillary tooth-row, exclusive of incisors, 37.

Specimens examined.—The type and a half-grown female with exactly similar coloration.

Remarks.—Its rather larger size, paler, less fulvous ground-colour, smaller bullæ, and broader skull serve to distinguish this animal from *P. minor* of the type-region; in addition, the tooth-

* Measurements in parentheses those of the type of *P. minor*, an adult female from Jalor, Peninsular Siam.

row is a little more deflected. This latter character, apart from smaller size, may serve to separate the *minor* from the *hermaphroditus* section, in which the maxillary tooth-row is less bent, since the outer lobes of *m*¹ are more in line. In the Koh Kut animal the great breadth of the skull near the posterior roots of the zygomata causes it to have a very heart- or pear-shaped outline.

The only examples of *P. minor* hitherto recorded from Indo-China are two young individuals collected by Dr. Vassal in Annam (Bonhote, P. Z. S. 1907, vol. i. p. 6).

8. *MARTES FLAVIGULA INDOCHINENSIS*, subsp. n.

Martes flavigula de Pousargues, Mission Pavie, Indo-Chine, Études Diverses, iii. p. 521 (1904)?

Type. Adult female (skin and skull), No. 1860/C.B.K. B.M. 15.11.4.40. Collected at Klong Menao, S.E. Siam, on 9th January, 1915.

Characters.—Closely resembling in colour *Martes flavigula*, but considerably smaller, with naked soles, harsh fur, and broad-lobed posterior molar, agreeing in these respects with the equatorial members of the group.

Colour.—Entire upper surface of head and neck to shoulders, including ears, hind feet, and tail, deep brownish black; distal half of fore legs, rump, base of tail, and hind limbs blackish brown, these colours gradually changing into honey-yellow between the shoulders and hind quarters, the median dorsal line being washed throughout with mummy-brown, most strongly posteriorly. Sides of neck between ears and shoulders bright buff-yellow; sides of upper lip, chin, and throat white; under-side of neck and fore-chest dirty white tinged with yellow; chest and abdomen cartridge-buff. Inner sides of ears mummy-brown edged with whitish and with an indistinct central patch of the same colour.

Skull and Teeth.—Do not appear to differ from those of *M. f. peninsularis* Bonhote (8 specimens examined), except that the skull is a trifle larger and the bullæ a little larger and more dilated.

Measurements *.—External measurements, taken in the flesh: head and body, 480 (430) mm.; tail, 385 (383); hind foot, 96 (85); ear, 38 (32). Skull: greatest length, 91 (90); basal length, 85.5 (83.5); length of palate from henselion, 42 (41); least palatal breadth between carnassials, 13.5 (15); breadth at post-orbital constriction, 24.5 (21.5); zygomatic breadth, 51 (49.5).

Specimens examined.—One, the type.

Remarks.—In colour this animal seems closely to resemble *M. f. flavigula*, ranging from Nepal to Burma, but its naked soles, short harsh fur, small size, and broad inner lobe of the posterior molar place it in the equatorial section of the group

* Measurements in parentheses those of an adult female *M. f. peninsularis* from Traug, Peninsular Siam: F. M. S. Mus. No. 1142/10.

and separate it from the true *M. flavigula* according to Mr. J. L. Bonhote in Ann. & Mag. Nat. Hist. ser. 7, vol. xii. p. 342 *et seq.* (1901), who there reviewed the group.

Since writing the above paper Mr. Bonhote has recorded two examples of the true *M. f. flavigula* from Chiangmai, Northern Siam (P. Z. S. 1902, part i. p. 38), thus increasing the range of this form. These examples are much larger than the individual under discussion here, so that it would appear that there are in Siam two races similar in colour but differing in size and in the characters given above. Were it not for these latter it would be most convenient to regard the south-eastern animal simply as a small race of *M. flavigula*.

9. TUPAIA CONCOLOR Bonhote.

Tupaia concolor Bonhote, Abstract P. Z. S. 1907, p. 2; id., P. Z. S. 1907, p. 7; Lyon, Proc. U.S. Nat. Mus. vol. xlv. p. 59 (1913).

Tupaia belangeri de Pousargues, Mission Pavie, Indo-Chine, Études Diverses, iii. p. 520 (1904); Gyldenstolpe (partim), Arkiv för Zoologi, Band 8, No. 23, p. 9 (1914).

2 males, 2 females, Ok Yam, Franco-Siamese Boundary; 3 males, 5 females, Klong Yai; 2 males, 2 females, Klong Menao, S.E. Siam.

These animals are intermediate between *T. belangeri* Schreb., of Pegu and Tenasserim, and *T. concolor* Bonhote, known from Southern Annam and Cochin-China. On the whole, however, they most closely approximate to the latter, though the pale shoulder-stripe is perhaps a little more marked, and so I have assigned them to it on geographic grounds. Several of them which are faintly washed on the rump with ochraceous, nearly resemble examples of *T. belangeri* from Southern Tenasserim, but the annulations anteriorly are somewhat coarser, while the buff is of a slightly deeper shade. There are three pairs of mammæ as in *T. belangeri*; in *T. concolor* the number is unfortunately unknown, as are the external measurements. The present animals are somewhat larger than *T. belangeri*, while the dimensions of the skulls are similar to those of skulls from Annam and Cochin-China.

Measurements.—Ears of the series, 15–20 mm. For other measurements see table, p. 68.

10. TUPAIA CONCOLOR SINUS, subsp. n.

Type. Adult male (skin and skull), No. 1422/C.B.K. B.M. No. 15.11.4.31. Collected on Koh Chang Id., S.E. Siam, 7th December, 1914.

Characters.—Like *T. concolor*, from the adjacent mainland, but smaller, darker, with yellower under surface and a conspicuous shoulder-stripe.

Colour.—Entire upper surface a grizzle of ochraceous buff and

blackish, the crown more ochraceous, the tail blacker, and the sides and limbs more buffy, but no difference in tone between the shoulders and rump; shoulder-stripe conspicuous cream-buff. Chin, throat, chest, and median abdomen buff-yellow; underside of thighs buffy-grey, of fore limbs buffy. Hairs of tail below with two distinct buffy annulations and a narrow subterminal one slightly deeper in shade. Ears dark.

Skull and Teeth.—Do not differ from *T. concolor* except in size.

Measurements.—Ears of the series, 15–18 mm. For other measurements see table, p. 68.

Specimens examined.—Seven, 4 males and 3 females, from the type-locality.

Remarks.—Only one island race of *Tupaia*, the present form, was met with during the excursion, the family being unrepresented on the large island of Koh Kut. *T. c. sinus* is a well-marked insular race, clearly differentiated by smaller size, concolorous dorsal area, and conspicuous shoulder-stripe.

11. DENDROGALE FRENATA Gray.

Tupaia frenata Gray, Ann. & Mag. Nat. Hist. ser. 3, vol. vi. p. 217 (1860).

Dendrogale frenata de Pousargues, Mission Pavie, Indo-Chine, Études Diverses, iii. p. 520 (1904); Bonhote, P. Z. S. 1907, p. 8; Lyon, Proc. U.S. Nat. Mus. vol. xlv. p. 128 (1913).

1 male, 1 female, Klong Menao; 1 female, Klong Yai, S.E. Siam.

Recently Dr. M. W. Lyon has so carefully characterised this species in his monograph on the Tupaiidæ (*loc. cit. supra*), that there is little more to add. His description, however, apparently applies to the female, as the two examples of that sex now obtained most closely agree with it, while the male is both larger and of richer colouring, with darker tail, the upper surface of the body being more tawny, the under surface of a richer buff, while the bright areas of the head are buff-yellow (*Ridgway* 1912). These differences have not hitherto been properly allocated, as the sex of the few specimens previously collected was unknown.

With regard to the head-markings, it may be further noted:—The black line through the eye is continued over the inner side of the ear, and the buffy cheek-colour runs round the lower edge of the ear to the back of this. There occurs also below the eye a narrow black line running from the upper lip to the roots of the cheek-vibrissæ. The buff of the thigh continues along the outer side of the foot and spreads over part of its upper surface, while the toes are largely buffy.

Dr. Lyon remarks of this and the allied *D. murina* from Western Borneo, that their scarcity in collections may probably be due to some peculiarity of habit making them difficult to

secure. My experience of *D. frenata* is that it does not come to traps, as do other Tupaiidæ. It runs about on the ground or along the roots of large trees, and being an extremely shy and inconspicuous little animal, is not easy to see or to shoot.

Measurements.—Ears of the series, 12–13 mm. For other measurements see table, p. 69.

12. *PTEROPUS HYPOMELANUS CONDORENSIS* Pet.

1602. ♀ ad. Koh Mak. 19th December, 1914.

1628. ♀ juv.; 1629. ♀ subad.; 1630. ♀ subad. Koh Mak. 20th December, 1914.

1656. ♂ ad.; 1657. ♂ ad.; 1658. ♂ subad. Koh Rang. 21st December, 1914.

“In the three fully adult specimens, one from Koh Mak and two from Koh Rang, the forearm measures 138–142 mm., the skull (total length) 62–67, the lower jaw (condyle to front of incisors) 49·8–53·5, and the maxillary tooth-row (c^1-m^2 , crowns) 24–25·5.

“Though not very large, this series beautifully illustrates the individual colour-variations in this bat. I should not be surprised if they represent approximately the extremes in colour, besides, of course, several intermediate stages. The mantle varies from a tinge a little paler than “hazel” (Ridgway, pl. iv. no. 12*: ♂ subad., Koh Rang, 1658), through several darker tinges, to warm glossy seal-brown (pl. iii. no. 1: ♀ ad., Koh Mak, 1602). The underparts are, in two individuals (♀ juv., Koh Mak, 1628, and ♂ ad., Koh Rang, 1656), quite or very nearly uniform dull seal-brown; in one (♀ ad., Koh Mak, 1602) there is just a faint suggestion of a deep chocolate tinge in the central area of the breast and belly, in others this same area becomes gradually lighter in colour, the extreme being a quite pale shade of russet (considerably paler and more buffy than Ridgway's pl. iii. no. 16: ♀ subad., Koh Mak, 1629). The back varies from blackish seal-brown to a tinge almost like ‘burnt umber,’ and is sometimes nearly uniform, but more often thinly, sometimes rather thickly, sprinkled with greyish hairs.

“The variations as described above are entirely independent of the sex and age of the individuals.

“These are the first specimens of *condorensis* I have seen since working out the genus *Pteropus* for the British Museum Catalogue of Chiroptera. My material then was the type in Berlin and the paratypes in Paris, from Pulo Condor (off S.E. Lower Cochin-China), all of which are mounted and faded, and an old and much faded skin in the British Museum labelled ‘Siam’ (Finlayson). Judging from the present fresh and well-preserved series, I am inclined to think that *condorensis* will have to be put down as a synonym of *Pt. hypomelanus tomesi*.

* The colours in my ‘Catalogue of Megachiroptera’ were named from the old edition of Ridgway's ‘Nomenclature of Colours’ (1886). To avoid confusion I use the same book for my description of the colours here.

But before giving any definite opinion I should like to see fresh material from Pulo Condor."—*Knud Andersen*.

[Bats of the *hypomelanus* species are apparently strictly confined to small islands, and do not occur on the mainland or on large islands, however closely their homes may be situated to such regions.

The *vampyrus* species, on the other hand, is largely of continental habitat, or, if living on islands, the animals are of greater size and more nearly related to the mainland forms than are those of the *hypomelanus* species; and except on one of the Natuna Islands, representatives of the two species never seem to occur side by side.—*C. B. K.*]

13. PTEROPUS VAMPYRUS MALACCENSIS K. And.

1671. ♀ juv.; 1672. ♂ ad.; 1673. ♂ ad.; 1674. ♀ ad. Koh Kut. 23rd December, 1914.

1690. ♂ ad. Koh Kut. 24th December, 1914.

1732. ♀ subad.; 1748. ♂ subad. Koh Kut. 26th December, 1914.

"No. 1671 is not nearly full-grown. No. 1732 is perhaps externally full-sized, and the skull very nearly so.

"In the four fully adult specimens the forearm varies between 190–204 mm. (this lowers the minimum given in my Catalogue by 5 mm., but it is easy to see that my material did not show the real extremes in size; the then available measurements of the forearm were 195–209, but as the variation in length of forearm in any species or subspecies of *Pteropus* is usually at least ten per cent., 190–209 comes probably nearer the true extremes); the skull (total length) measures 77·5–81, the lower jaw (from condyle) 60·5–64, and the maxillary tooth-row (crowns) 30–30·7.

"The six specimens are not peculiar in any respect. In colour they exhibit no more variation than usual in *Pt. v. malaccensis*, i. e. a lighter or deeper tinge of the mantle and head, and a thinner or heavier admixture of greyish hairs on back and underparts.

"*Pt. v. malaccensis* was known to be generally distributed over Sumatra, including Banka and the Linga Archipelago, and northwards through the Malay Peninsula to Jalor and Patani. The present series extends its range across the Gulf of Siam to the island of Koh Kut, off S.E. Siam.

"Three years ago, in the new British Museum Catalogue of Chiroptera (vol. i. p. 325, in the paragraph 'Differentiation of species') I hinted at the possibility that a completed material might show a gradual transition from *Pt. giganteus* ('*Pt. medius*' of Dobson's Catalogue) to *Pt. vampyrus* ('*Pt. edulis*'). But time was not ripe then for any final conclusion on this subject, and I preferred, in order not to prejudice matters, simply to record the distinguishable forms under four headings:—

"(1) *Pt. giganteus* (two races) from India and Ceylon, north and north-east to Nepal, Assam, and Manipur—represented in the

Maldive Archipelago by (2) *Pt. ariel*, in Tenasserim by (3) *Pt. intermedius*, and in the Malay Peninsula and Indo-Malayan Archipelago by (4) *Pt. vampyrus* (six races). A fifth form, *Pt. lylei* (Siam and Saigon) appears to be a perfectly distinct species.

"Since then the Mammal Survey of India, carried out under the auspices of the Bombay Natural History Society, has enormously increased our knowledge of the range of variation of *Pt. giganteus*, and everything I have seen so far tends to confirm my belief that future systematists will be compelled to regard *giganteus*, *ariel*, *intermedius*, and *vampyrus* as local representatives ('subspecies') of one species, *Pt. vampyrus*—*intermedius* being (as the technical name was intended by me to indicate), both geographically and in its characters, the connecting-link between the western (Indian and Indo-Chinese) *giganteus* and the eastern (Indo-Malayan) *vampyrus*, and *ariel*, an only slightly and probably imperfectly differentiated island form of *giganteus*."—*Knud Andersen*.

[The occurrence of this animal on Koh Kut is interesting, as it must apparently have arrived there by flight from the Malay Peninsula across the Gulf of Siam—a journey over water of about 250 miles—since the only flying-fox known on the mainland from Bangkok to Siam is *P. lylei*, a very distinct species, while the continent west of Bangkok is apparently occupied by another species, *P. intermedius*.—*C. B. K.*]

14. *CYNOPTERUS BRACHYOTIS ANGULATUS* Miller.

15. *CYNOPTERUS BRACHYOTIS BRACHYOTIS* S. Müller.

1437–1440. All ♂ ad. Koh Chang. 7th December, 1914.

1508. ♂ ad, Koh Mehsi East. 13th December, 1914.

1579. ♂ ad.; 1580. ♂ ad.; 1581. ♀ ad.; 1582. ♀ ad.; 1583. ♀ ad. Koh Kra. 17th December, 1914.

1599. ♂ ad.; 1600. ♀ subad.; 1601. ♀ ad, Koh Klum. 18th December, 1914.

1786. ♂ ad. Koh Kut, 30th December, 1914.

"The four specimens from Koh Chang I refer to *C. b. angulatus*; all the others are undoubtedly *C. b. brachyotis*.

"I have carefully examined and measured all the specimens. Unfortunately, all being skins*, I have been unable to verify the collector's measurements of the ears, as given on the label of each specimen. Not that I have the slightest doubt of the accuracy of his measurements, but what I do have is a strong

* I should like to take this opportunity of urging on collectors the advisability of preserving in alcohol a fairly good number of the bats obtained. Skins are indispensable for a study of the colours of the fur, but the shape and size of the ears and (in leaf-nosed bats) the details of the nose-leaves are in this group of mammals such important items that I often, during my work for the Catalogue, have had to deplore the now almost universal habit of experienced collectors of making nearly every good specimen of a bat into a skin. My earnest advice is, if only one specimen is obtained, put it in alcohol, if several, put about half of them (and not only the most badly damaged ones) in alcohol.—*K. A.*

suspicion that his method of measuring the ears of a *Cynopterus* is different from mine, and his measurements, therefore, not directly comparable with those given by me in the new 'Catalogue of Chiroptera.' If they were, then the four specimens from Koh Chang, though having a cranial rostrum perfectly similar to that of *C. b. angulatus*, would possess ears as long as, or (in three out of four cases) conspicuously longer than, any *C. sphinx sphinx* I have seen. It is only natural, I think, that before admitting the existence of such specimens I should like to verify their characters on alcohol material. Also the 'collector's measurements' of the ears of the ten *C. b. brachyotis* are unusually large.

"In the specimens of *brachyotis* the forearm measures 58-66 mm. (57-66: I add everywhere in parentheses, for comparison, the corresponding measurements taken by me on the large series examined for the 'Catalogue of Chiroptera'), in the four *angulatus* 66-70 (65-72); ear, collector's measurements, *brachyotis* '15.5-18' (15-17), *angulatus* '18.3-21' (16-18); skull, lambda to gnathion, *brachyotis* 28.5-29.8 (27-30.7), *angulatus* 32-33 (30.5-33.2); rostrum, orbit to nares, *brachyotis* 6.7-7.3 (6-7.4), *angulatus* 7.2-7.5 (6.5-8.2); mandible, *brachyotis* 21.5-22.8 (20.2-22.8), *angulatus* 24.2-25 (22.8-25.5); maxillary teeth (crowns), *brachyotis* 9.2-10.4 (8.8-10.4), *angulatus* 10.2-10.8 (10.2-11.3).

"If all the fourteen specimens are placed in a row the practised eye will easily pick out the four *angulatus*, owing to a different, but hardly describable, tinge of the colour of the upper side. If, similarly, the skulls are placed in a row those of *angulatus* are, of course, distinguishable at a glance by their conspicuously longer size (see measurements above).

"Of course, if a form really does exist, in the north of the Malay Peninsula, in the islands off S.E. Siam, and possibly somewhere else, which possesses the skull of *angulatus**, but the ears of *sphinx*†, then an entirely new and unsuspected element is introduced into the genus. But unless and until the existence of such a form is properly established, I should think it rather premature to discuss its probable effect on our arrangement."—*Knud Andersen*.

[Dr. Andersen's notes seem to call for some remark. With regard to the measurement I am satisfied that that used by me is the same as his, i. e. 'from orifice' (to the extreme tip understood). It is the only one of the outer external side that can be taken with any certainty and uniformity, and is so obvious that it suggests itself to every collector. The only possible alternative is the length of the inner external side from tip to base on the crown—quite another thing and not to be confounded with the former.

* Cranial rostrum (orbit to nares) less than one-fourth of skull (lambda to gnathion).

† Ears from orifice (18-20.5 mm.).

Now *C. angulatus* Miller, does have long ears, for the measurements of the type series are given as 18–21 mm.* The type-locality is Trang, S. Peninsular Siam or, to put it another way, Central Malay Peninsula. Recently Messrs. H. C. Robinson and E. Seimund obtained a series of bats from Bandon (about 100 miles to the north of this) and the adjacent islands of Koh Samui and Koh Pennan, with ears which they found to range between 18·5–21 mm.†, while I, again, consider my Koh Chang specimens to have ears of 18·5–21 mm. It is impossible to ignore the evidence of so many independent observers, which goes to prove that a bat with the long ears of Dr. Andersen's *sphinx* really does occur in this region.

The question then arises as to what is the *angulatus* of Andersen, based on a large mass of heterogeneous material from an extensive region, ranging from Assam and Annam to Sumatra and the islands off its western coast. Though it includes six of Miller's type series, three of which have the ear-length recorded as above, our author does not seem to have taken this statement into consideration.

Now Dr. Andersen recorded *C. brachyotis brachyotis* as also occurring throughout Sumatra and the Malay Peninsula as far north as Trang (and now in the islands of S.E. Siam), so that if *angulatus* is to be accepted as a form of *brachyotis*, as he desires, we have an instance of two subspecies of the same species living side by side; or, in other words, two geographical races or local forms occurring in the same place—a thing which most zoologists will flatly refuse to admit: they must either be the same thing or forms of two species.

Again, if on account of the long ears (which I think must be accepted as occurring in the Malay Peninsula and islands of Siam at any rate) we regard *angulatus* as a form of *sphinx*, we should have, if the long-eared *angulatus* occurs there too, a similar questionable state of affairs existing in Sumatra, which is inhabited by *tithæcheilus*, also, according to Andersen, a form of *sphinx*. So we are left with three alternatives: either *angulatus* has no real existence, the material forming it being part *sphinx* and part *brachyotis*—not very probable; or it is a very plastic and comprehensive form of the latter, of which the typical race is non-existent in Sumatra and the mainland; or it is an independent species. In the last case its central position is good reason for the possession of characters appertaining to both the other species:—long ears of *sphinx*, short rostrum of *brachyotis*, and medium size. And to explain the occurrence of all species in one locality to-day we may imagine *sphinx* extending eastward from Ceylon, *angulatus* southward from Indo-China, and *brachyotis* westward from, for present purposes—say, Borneo: all converging on Sumatra—probably the home of the other section of the genus *Nyctidius*. Or conversely, all species of *Cynopterus*

* Miller, Proc. Acad. Nat. Sciences, Philadelphia, 1898, p. 316.

† Robinson & Kloss, Journ. F. M. S. Museums, vol. v. pp. 115; 134 (1915).

originated in the latter locality, and in the race for expansion the last got left at the post.—*C. B. K.*].

16. *RATUFA MELANOPEPLA LEUCOGENYS*, subsp. n.

Sciurus javensis Gray, P. Z. S. 1861, p. 137.

Sciurus bicolor de Pousargues, Mission Pavie, Indo-Chine, Études Diverses, iii. p. 582 (1904).

Ratufa melanopepla Gyldenstolpe, Arkiv för Zoologi, Band 8, No. 23, p. 15 (1914).

Type. Adult female (skin and skull), No. 1912/C.B.K. B.M. No. 15.11.4.43. Collected at Lam Ngop, S.E. Siam, on 15th January, 1915.

Characters.—Like *R. m. peninsule* Miller (Proc. Washington Acad. Sci. vol. ii. p. 71, 1900; id., Smithsonian Miscellaneous Collections, vol. lxi. No. 21, p. 25, 1913), but yellow of cheeks, fore limbs, and under surface markedly paler than the respective areas in that form, yellow on thighs more extensive and continued along the sides of the feet on to their upper surfaces, where it occupies a considerable area, while the yellow of the fore limb extends to the base of the toes above.

Colour.—Upper surface and entire tail brownish black; a fairly conspicuous russet patch on the nape. Under surface pale orange-yellow. Cheeks to base of ear, but not reaching the eye, lower sides of neck, greater part of upper side of fore limb to base of toes ivory-yellow, becoming cream-colour on the posterior part of the fore limb. The yellow area of the under thigh continued as ivory-yellow along the outer side of the foot and on to the upper surface of the latter, where it occupies almost half of the area between the ankle and bases of the toes. Sides of muzzle like throat, but chin black.

Skull and teeth.—Possess apparently no constant features which will separate them from topotypes of *R. m. peninsule*, from Trang, and others from Bandon, 100 miles to the north in Peninsular Siam. On the whole, the bullæ appear to be a little longer.

Measurements.—Ears of the type 30.5, of the series 29.5–30.5 mm. For other measurements see table, p. 69.

Specimens examined.—Three, the type and two adult males from the same locality.

Remarks.—This race is separated from that of the Malay Peninsula by its pale yellow coloration and large yellow patch on the hind foot, while the yellow of the fore limb is greater in extent, reaching the base of the toes.

The individual obtained by Gyldenstolpe (*loc. cit. supra*) in Eastern Siam, south of Korat, is, judging from its measurements, of this form. *Ratufa phaeopepla* Miller (Smithsonian Miscellaneous Collections, vol. lxi. No. 21, p. 25, 1913), from South Tenasserim should occur also in Western Siam. It is like the animal of the Peninsula, but larger (hind foot 80–89, skull 74–78 mm.). Flower (P. Z. S. 1900, p. 355) records a black-and-

yellow Giant Squirrel from Phrabat, and observed another near Paknam Kabin which he believed had tufted ears. This feature would apparently indicate the presence near Bangkok of *Ratufa gigantea* McClelland, which, according to Wroughton (Journ. Bombay Nat. Hist. Soc. vol. xix. p. 890, 1910), also occurs in N. Siam. It is a large black-and-buff animal (head and body 417 mm., hind foot 87, skull 80), with the yellow on the fore limb confined to the inner side.

17. *RATUFA MELANOPEPLA SINUS*, subsp. n.

Type. Adult female (skin and skull), No. 1733/C.B.K. B.M. No. 15.11.4.41. Collected on Koh Kut Id., S.E. Siam, on 26th December, 1914.

Characters.—Like *R. m. peninsulae* Miller, but uniform black above with the under surface rather more ochraceous and extending slightly to the upper surface of the hind foot, while the yellow of the fore limb extends to the base of the toes above. Nasals rather longer.

Colour.—Upper surface and entire tail clear black. Under surface varying from ochraceous buff to ochraceous orange and ochraceous tawny in centre of abdomen. Cheeks to base of ear, sides of neck, and upper and inner side of fore limbs pale orange-yellow, deeper on the inner side of fore limbs. A small area of ochraceous buff on the outer and upper sides of the hind foot. Sides of muzzle like throat, but chin black.

Skull and Teeth.—Resemble those of *R. m. peninsulae* and *R. m. leucogenys*, except for the greater length of the nasals, the posterior terminations of which are more in line with those of the premaxillaries. The bullæ are apparently a little shorter and broader.

Measurements.—Ears of the type 30, of the series 27–30 mm. For other measurements see table, p. 69.

Specimens examined.—Six adults, 3 males and 3 females.

Remarks.—This form differs from that of the adjacent mainland in being uniformly clear black above without any nuchal spot. The yellow areas are deeper in shade, those of the head, neck, and fore limbs being of about the same tone as the abdomen of *R. m. leucogenys*, while the patch of yellow on the upper side of the hind foot is smaller and somewhat disconnected from the yellow of the thigh.

This and the preceding race both differ from the Peninsular form in the constant presence of a considerable amount of yellow on the hind and fore feet. *Inter se*, the differences in colour are very marked, though those of the dorsal surface may be only seasonal. Size is about the same in all (a trifle larger in the S.E. Siamese forms), but the longer nasals of the island race further serve to distinguish it from both the others.

It may be pointed out that the forms from the islands of the Malayan part of the Peninsula (Teratau, Langkawi, Penang, and Tioman), *i. e.*, southern island forms, are all instantly separated

from the mainland races and from Siamese island forms (Telibon, Samui, Pennan, and Kut) by their deep ochraceous-tawny under surfaces and by the greater amount of black on the inner side of the hind limbs.

Though the island of Koh Chang is larger than Koh Kut, nearer to the mainland, and in much shallower water, no form of Giant Squirrel occurs on it. Yet the *Ratufa* of Siam was found immediately opposite the former, whereas all along the coast in the vicinity of Koh Kut it was not met with.

18. *SCIURUS FERRUGINEUS CINNAMOMEUS* Temm.

Sciurus cinnamomeus Temminck, Esq. Zool. Guiné, 1853. p. 250; Wroughton, Ann. & Mag. Nat. Hist. ser. 8, vol. ii. p. 396 (1908); Gyldenstolpe, Arkiv för Zoologi, Band 8, No. 23, p. 12 (1914).

Sciurus splendens Gray, P. Z. S. 1861, p. 137.

Sciurus ferrugineus Anderson, Zoological Researches, p. 244 (1878); de Pousargues, Mission Pavie, Indo-Chine, Etudes Diverses, iii. p. 526 (1904).

Sciurus finlaysoni Flower (partim), P. Z. S. 1900, p. 355.

Sciurus finlaysoni. Type B (*Sc. splendens*), Bonhote, P. Z. S. 1901, vol. i. p. 53.

6 males, 7 females, Ok Yam, Franco-Siamese Boundary; 2 males, 3 females, Klong Yai; 2 males, 1 female, Klong Menao; 3 males, 2 females, Lem Ngop, S.E. Siam.

The above specimens show a certain amount of variation in colour. On the whole, however, they most nearly approach *Sciurus splendens*, var. 2 of Gray (= *cinnamomeus* Temm.). "Top of head (and top of back by inference) and tail dark and very intense red-bay; side of the back, under sides of the body, and tip of tail paler red-bay." A few approximate to var. 3. "Uniform pale bay, like the side of var. 2; tail and middle of the back rather darker and brighter; tail without pale tip," though the latter shows some signs of "bleaching" at the extremity. The majority of the collection have the sides of the head grizzled greyish, and there are traces of grizzling on the fore limbs: these latter features, together with an indication of grizzling on the thighs, being most pronounced among the five examples from Lem Ngop, the western extremity of the series. Again, two or three approach var. 1, "all over dark and very intense red-bay," except that they have no "white spot on each side of the base of the tail."

Measurements.—Ears of the series 19–23 mm. For other measurements see table, p. 70.

I do not know from what locality Temminck's *Sciurus cinnamomeus* came, and we have also no details as to the provenance of the animals on which Gray founded his species, beyond the fact that their collector, Mouhot, travelled widely in Siam and Cambodia; but it appears to me that when the Red Squirrel is fully known over the whole of its range it will be necessary to recognise several geographical races; to all of which the

opinion of Anderson (*op. cit.* p. 245) with regard to *S. cinnamomeus* will likewise apply, *i. e.*, that they are only local forms of *S. ferrugineus*.

Even in the present series, collected along a 50-mile stretch of coast, there are indications of geographical variation; for the eight specimens from the northern stations (Lem Ngop and Klong Menao) most nearly resemble Gray's var. 3, while, with the exception of three or four individuals like them, the eighteen darker southern animals come nearer var. 2.

19. *SCIURUS FERRUGINEUS FRANDSENI*, subsp. n.

Type. Adult male (skin and skull), No. 1502/C.B.K. B.M. No. 15.11.4.85. Collected on Koh Chang Id., S.E. Siam, 12th December, 1914.

Characters.—Like *S. f. cinnamomeus* of the adjacent mainland, but with chin, throat, sides of head, outer sides of fore and hind limbs grizzled blackish or olive-brown.

Colour.—Top of head, upper part of body, and tail intense shining red-bay, becoming more fulvous towards the sides and on the thighs and behind the ears, the hairs black-tipped except on the distal half of the tail, which is clear reddish chestnut, somewhat bleached to fulvous at the extremity.

Muzzle, sides of head, chin, throat, shoulders, and sides of body olive-brown variably annulated with buff-yellow, strongest on throat and flanks; the shoulders, outer sides of fore limbs and thighs becoming black, finely annulated with buff. Entire under surface, except chin and throat, rich tawny, this colour extending to the fore feet and also to the hind feet, where it is mingled with black. There is a faintly indicated grizzled line down the centre of the chest and abdomen. Ears like the hind feet, their bases posteriorly dull ochraceous buffy.

Skull and Teeth.—As in the mainland race.

Measurements.—Type: Ear, 22 mm. Skull: basilar length, 44.4; brain-case breadth, 20; proximal breadth of nasals, 4; distal breadth of nasals, 8. Ears of the series, 19–22 mm. For other measurements see table, p. 70.

Specimens examined.—Sixteen, 9 males and 7 females, all from the type-locality.

Remarks.—In some of these animals the extent of black on the head is almost sufficient to form a black line between the crown and the grizzled portion of the face, and the fore feet are also partially black; in others the under surface is somewhat more orange than in the type.

The definition of *Sciurus splendens* var. 4, Gray (P. Z. S. 1861, p. 137), applies to some extent, as does also Anderson's description (Zool. Res. pp. 245–6) of an example considered by him to be *S. siamensis* Gray. The locality from which these latter two specimens came is unknown and, though I am unaware that Koh Chang has been previously visited by any naturalist, such may have been the case. The characters of *S. f. frandseni* are

so regular throughout in the series of sixteen as to render it an extremely distinct race, even though, as recorded above, animals from Lem Ngop (the nearest point of the mainland), having indications of grizzling on the thighs, tend to connect it with the more typical *cinnamomeus* animal. It is named after Captain H. E. Frandsen, R.N.R., Denmark, to whom I am indebted for much assistance and interesting information while in S.E. Siam.

20. *SCIURUS ALBIVEXILLI*, sp. n.

Type. Adult male (skin and skull), No. 1724/C.B.K. B.M. No. 15.11.4.46. Collected on Koh Kut Id., S.E. Siam, 25th December, 1914.

Characters and Colour.—Black throughout except the extremity of the tail, which is white.

Skull and Teeth.—As in *S. cinnamomeus*.

Measurements.—Type: Ear, 20.5 mm. Skull: basilar length, 436.; brain-case breadth, 25.2; proximal breadth of nasals, 7; distal breadth of nasals, 4.4. Ears of the series, 19–21.5. For other measurements see table, p. 70.

Specimens examined.—Twenty-three, 12 males and 11 females, all from the type-locality.

Remarks.—*S. albivexilli* is somewhat variable in respect of the white tail-tip. In some animals the last 3 to 4 inches of the tail are white, and there is a white ring close to the bases of the hairs for the distal three-fourths of the tail; in others there are no annulations, and the pale tip is reduced to a bunch of greyish hairs at the extreme end.

Two other forms of Black Squirrel occur in Indo-China: *S. nox* Wroughton (Ann. & Mag. Nat. Hist. ser. 8, vol. ii. p. 397, 1908), in the neighbourhood of Siracha, on the eastern shore of the Inner Gulf near Bangkok, and *S. germaini* Milne-Edwards (Rev. Zool. 1867, p. 193) on Pulo Condor, south-east coast of Cochin-China: both are black throughout, but the latter is much smaller than the other. On distributional grounds it seems impossible to treat them and the present form as local races of one species, as there is no geographical connection, the mainland everywhere in the vicinity of Koh Kut being occupied by the red *S. cinnamomeus*.

The latter is, however, known to develop a white tail-tip, and it is possible that through *S. f. frandseni*, with its black-tipped upper pelage, blackish fore limbs and thighs, a connection may be traced between the Koh Kut animal and *S. cinnamomeus*. It is, however, very slight.

21. *TAMIOPS RODOLPHI* M.-E.

Sciurus rodolphi Milne-Edwards, Rev. et Mag. de Zool. xix. p. 227 (1867); id., Rech. Mamm. 1871, p. 162; de Pousargues, Mission Pavie, Indo-Chine, Études Diverses, iii. p. 528 (1904).

Sciurus maccllellandi rodolphi Bonhote, Ann. & Mag. Nat. Hist. ser. 7, vol. v. p. 54 (1900); id., P. Z. S. 1907, p. 10.

1 male, 1 female, from Lem Ngop, S.E. Siam.

I have not seen specimens of this squirrel from the type-locality (Cochin-China), nor is Milne-Edwards's description accessible to me, but Mr. Bonhote's remarks (*loc. cit. supra*) on examples from Cochin-China and Annam appear to apply to the individuals obtained in S.E. Siam.

The dark stripes are all grizzled with brown, the median black one being divided down the centre by a grizzled brown line, and the four light dorsal stripes are of equal breadth and distinctness, as stated by Mr. Bonhote; but while the outer two are cream-coloured, the inner pair are buff-yellow and show none of the pink tinge noted by him. The underparts are buff-yellow, not ferruginous, but this may be a matter of terms. The white tufts of the ears are black at their bases.

Measurements.—Ears, 13 mm. For other measurements see table, p. 72.

Another form of *Tamias* found in Siam is *T. novemlineatus* (Miller), which inhabits the Malay Peninsula, certainly as far north as the Isthmus of Kra. Bonhote (P. Z. S. 1901, i. p. 54) has described, under the name *kongensis*, animals obtained at Raheng and Nan, but these appear to differ from the *Tenasserim barbei* by just the same characters as does *novemlineatus*, so that it is doubtful whether they are really distinct from the latter.

22. MENETES BERDMOREI MOUHOTII Gray.

Sciurus mouhotii Gray, P. Z. S. 1861, p. 137.

Sciurus pyrrhocephalus Milne-Edwards, Rev. Zool. xix. 1867, p. 225; de Pousargues, Mission Pavie, Indo-Chine, Études Diverses, iii. p. 528 (1904).

Funambulus berdmorei Flower, P. Z. S. 1900, p. 359.

Menetes berdmorei Gyldenstolpe, Arkiv för Zoologi, Band 8, No. 23, p. 15 (1914).

Menetes berdmorei mouhoti Thomas, Journ. Bombay Nat. Hist. Soc. vol. xxiii. p. 23 (1914).

3 males, 3 females, Lem Ngop; 2 males, Klong Menao; 3 males, 2 females, Klong Yai, S.E. Siam; 1 male, 4 females, Ok Yam, Franco-Siamese Boundary.

I must confess that I find these specimens somewhat difficult to place. The only material available to me for comparison consists of four examples of *M. berdmorei berdmorei* from Martaban and Moulmein (Cat. Mamm. Indian Mus. specimens *a, b, c, d*) and a series of thirteen from Bandon, Peninsular Siam, which are apparently conspecific with those (*cf.* Robinson & Kloss, Journ. F. M. S. Museums, vol. v. p. 121, 1915), all of which are clearly distinguishable from the present series by the conspicuousness of the median dorsal and upper lateral blackish lines and somewhat smaller size.

Thomas, however, has recently reviewed the races of this squirrel (*loc. cit. supra*) and, though one would, on geographical grounds, place the present animals in the form *mouhotii*, one can also regard part of the series as of that subspecies as defined by him and allot the remainder to his new race *consularis* of Northern Siam. If we only knew the exact type-locality of *M. b. mouhotii*, given vaguely as Cambodia (Gray, *loc. cit. supra*), we should probably find that these S.E. Siamese animals are geographically, as they are in appearance, intermediate between the two.

Gray, who only had one specimen when describing *mouhotii*, makes no mention of any dark stripes between the upper pale ones, and *consularis* resembles his type in that respect. Thomas, however, in extending the range of *mouhotii* from south of Bangkok to Cochin-China, reports three inconspicuous black stripes on the back between the upper pale ones as in *berdmorei*: *mouhotii* is white or whitish below, *consularis* yellowish white. The series of 16 animals from S.E. Siam have backs ranging from three to no dark stripes and under surfaces from white to yellowish white.

The individuals from Eastern Siam (Korat) referred by Gyldenstolpe (*loc. cit. supra*) to *M. berdmorei* require further examination.

Thus, exclusive of the two island races described below, the following forms seem to inhabit our region: the true *berdmorei* in Peninsular and perhaps Western Siam; *consularis* in Northern and perhaps Eastern Siam; and *mouhotii* in South-eastern Siam.

The species seems to increase in size from west to east; the three forms mentioned here are all larger than those from Burma and the Malay Peninsula, and *M. b. moeresceus* from Annam (Thomas, *loc. cit. supra*) is believed to be larger also.

Measurements.—Ears of the series, 18.5–21 mm. For other measurements see table, p. 71.

23. MENETES BERDMOREI UMBROSUS, subsp. n.

Type. Adult female (skin and skull), No. 1449/C.B.K. B.M. No. 15.11.4.97. Collected on Koh Chang Id., S.E. Siam, 8th December, 1914.

Diagnosis.—Like *M. b. mouhotii* from the adjacent mainland, but darker above; the three upper dark stripes very faintly indicated by a blackish wash, the upper pale stripe narrower and a deeper buff, the lower also deeper in tint but less distinct, approaching in colour the outer side of the thighs; the sides of the abdomen between the limbs also darker. Under surface somewhat more deeply buffy. Tail more ochraceous, blacker and much less hoary.

Skull and Teeth.—As in the mainland animal.

Measurements.—Ears of the type, 20, of the series, 17.5–20 mm. For other measurements see table, p. 71.

Specimens examined.—Six, 3 males and 3 females.

Remarks.—There is extremely little variation in the series from Koh Chang, which is easily separated on the above characters from the mainland form. The dark dorsal stripes, though obsolete, are indicated by an increase in the amount of black annulation, but are not so intense in colour as the area between the lateral pale stripes.

24. *MENETES BERDMOREI RUFESCENS*, subsp. n.

Type. Adult female (skin and skull), No. 1740/C.B.K. B.M. No. 15.11.4.93. Collected on Koh Kut Id., S.E. Siam, 26th December, 1914.

Diagnosis.—Lighter and more rufous above than the neighbouring continental form, dark dorsal stripes absent, dark lateral stripe not deeper in colour than the back; upper pale stripe a little less intense, the lower much less distinct; sides of body bordering the abdomen considerably darker. Under surface slightly richer buff. Tail darker and much less hoary.

Skull and Teeth.—As in the mainland animal.

Measurements.—Ears of the type, 17, of the series, 17–22 mm. For other measurements see table, p. 71.

Specimens examined.—Nineteen, 11 males and 8 females.

Remarks.—As in the series of 18 examples from the adjacent mainland dealt with above, there is a certain amount of variation in the dorsal area of this race, some examples having the dark lateral dorsal stripes present to a slight degree and the median one just indicated: when this is the case the area between the pale lateral stripes is proportionately darker also. The other differences, however, are consistently maintained and the series further includes the largest animals obtained in this region.

25. *EPIMYS JERDONI MARINUS*, subsp. n.

Type. Adult male (skin and skull), No. 1455/C.B.K. B.M. No. 15.11.4.160. Collected on Koh Chang Id., S.E. Siam, 9th December, 1914.

Characters.—Resembles *Epimys jerdoni bukit* (Bonhote), but with the white of the under parts hardly ever extending to the foot, and tail rather shorter. Skull with smaller bullæ, larger palatal foramina, and broader interpterygoid space.

Colour.—Above ochraceous tawny, much darkened or streaked by the exposed tips of the numerous stiff spines which have greenish horn-coloured bases. Base of fur grey. Below yellowish white to the base of the hairs, extending over the fore limbs to the hands, but not quite reaching the hind feet, which are white with brownish centres. Tail bicoloured with a dark tip.

Skull and Teeth.—Like those of *E. j. bukit*, but with smaller and more flattened bullæ; broader interpterygoid space, the outline of which is more angular owing to the straighter anterior margin; palatal foramina larger, nearer the incisors, and the

nasals slightly more projecting anteriorly. In all except the first of these characters the skull more nearly resembles *E. j. pan* Robinson & Kloss, from Koh Samui Id. of the opposite side of the Gulf, but differs in the bullæ, which in that race agree with *E. j. bukit*.

Measurements.—Ear of type, 20 mm. For other measurements see table, p. 72.

Specimens examined.—Twenty-two from Koh Chang and twenty-three from Koh Kut.

Remarks.—Besides externally closely resembling *E. j. bukit*, this race is also very similar in appearance to *E. j. pan*. While, however, in the former the white of the under parts nearly always reaches to the foot, in *marinus* it generally just fails to do so, and in the latter it always stops considerably short of the ankle.

Although these rats were exceedingly common on the two islands none was met with on the mainland, so that I have had to compare them with animals from the Malay Peninsula, which Bonhote states (*Fasciculi Malayenses*, Zoology, part 1, p. 27) exactly agree with those of Siam: in which case *E. lepidus* Miller, founded on a single adult individual from Southern Tenasserim (an intermediate locality), is also probably an example of *E. j. bukit*. The position of this latter with regard to the true *E. jerdoni* (Blyth) of Sikkim is not fully known, but from the few details recorded of Darjiling specimens (Thomas, P. Z. S. 1881, p. 538; Blanford, Faun. Brit. India, Mammals, p. 411), it would appear that the typical animal is a smaller form having a tail actually, and so relatively much, longer than *bukit* (and therefore still longer than *marinus*).

In my experience the *jerdoni* rat is by no means common in the Malay Peninsula, and I failed to meet with it in S.E. Siam. Of the small islands of these areas, *E. j. pan* had only recently been discovered on Koh Samui, and I was therefore much surprised to find a form occurring in great abundance on the two larger islands of the Chantabun Archipelago, where it used to come into my camp at twilight in search of food.

The Koh Kut animals seem to be a trifle smaller than those of the type-locality, but apart from that I can detect no difference whatever.

26. *EPIMYS SURIFER FINIS*, subsp. n.

Type. Aged male (skin and skull), No. 1885/C.B.K. B.M. No. 15.11.4.117. Collected at Klong Menao, S.E. Siam, 11th January, 1915.

Characters.—Like *Epimys surifer* Miller, from Peninsular Siam (Trang), but duller; white of under surface normally extending to the ankle and over the bases of the vibrissæ.

Colour.—Upper surface ochraceous tawny, clouded on the back by the dark tips of the flattened spines. Under parts white, extending to the hind feet and to the roots of the vibrissæ, but

not always to the hands. Tail averaging longer than head and body, bicoloured with white tip. Hands and feet white.

Skull and Teeth.—Resemble those of the typical race and show no characters which will consistently serve to distinguish them from it.

Measurements.—Ear of type, 24.5 mm. For other measurements see table, p. 73.

Specimens examined.—Twenty-six: 3 from Ok Yam, 5 from Klong Yai, and 18 from Klong Menao.

Remarks.—The above series has been compared with a large series of topotypes from Trang, Peninsular Siam, and also with a number recently obtained in Bandon (about 100 miles to the north of that locality), and distinctly differs as pointed out; though, as is always the case with two neighbouring continental races, the extremes of the two series closely resemble each other. The extension of the white area to the foot occurs in the great majority of examples from S.E. Siam, whereas in series from Peninsular Siam the contrary is the case.

Epinys surifer has only previously been recorded from Siam by Gyldenstolpe (Arkiv för Zoologi, Band 8, No. 23, p. 16, 1914), who obtained a single example on the Korat Plateau.

27. *EPIMYS SURIFER CHANGENSIS*, subsp. n.

Type. Aged male (skin and skull), No. 1492/C.B.K. B.M. No. 15.11.4.142. Collected on Koh Chang Id., S.E. Siam, 11th December, 1914.

Diagnosis.—Like *E. s. finis*, but with tail averaging shorter than head and body, the dark speckle of the upper surface much coarser and the white of the under parts more extensive on limbs, broadening, in some examples across the body and spreading up the sides of the muzzle and over the upper side of the fore limb.

Measurements.—Ear of type, 25 mm. For other measurements see table, p. 73.

Specimens examined.—Thirty-three from the type-locality.

Remarks.—The tendency in this race to develop a white fore limb and a short tail approximates it to *E. s. manicalis* Robinson & Kloss*, from Koh Pennan on the opposite side of the Gulf of Siam, from which, however, it is clearly distinguished by its much duller upper colour.

28. *EPIMYS SURIFER KUTENSIS*, subsp. n.

Type. Aged male (skin and skull), No. 1710/C.B.K. B.M. No. 15.11.4.151. Collected on Koh Kut Id., S.E. Siam, 25th December, 1914.

Diagnosis.—Like *E. s. changensis*, but a trifle less tawny and with less tendency for the white areas to increase (in this coming nearer to the mainland form); anterior root of the zygomatic

* Ann. Mag. Nat. Hist. ser. 8, vol. xiii. p. 230 (1914).

arch much narrower than in the two preceding races, this diminution markedly increasing the size of the infraorbital foramina as seen from above.

Measurements.—Ear of type, 24 mm. For other measurements see table, p. 73.

Specimens examined.—Twenty-nine from Koh Kut.

29. *EPIMYS SURIFER PELAGIUS*, subsp. n.

Type. Adult male (skin and skull), No. 1659/C.B.K. B.M. No. 15.11.4.109. Collected on Koh Rang Id., S.E. Siam, 22nd December, 1914.

Diagnosis.—Colour bright clay, duller than the foregoing races, and further differing from the mainland animal in having the tail shorter than the head and body, from *E. s. changensis* in showing no tendency to extension of the white area, and from *E. s. kutensis* in the broader anterior zygomatic root.

Measurements.—Ear of type, 25 mm. For other measurements see table, p. 73.

Specimens examined.—Twenty-one, all from the type-locality.

30. *EPIMYS SURIFER CONNECTENS*, subsp. n.

Type. Adult female (skin and skull), No. 1613/C.B.K. B.M. No. 15.11.4.135. Collected on Koh Mak Id., S.E. Siam, 19th December, 1914.

Diagnosis.—Clay-coloured above, closely resembling *E. s. pelagius*, though with the white on the hind limb in some instances a little reduced towards the ankle. Skull with slightly broader nasals and rostrum, and profile less curved. This latter character is difficult to define, but if skulls are compared when resting on their upper sides, *connectens* skulls will be seen to have the anterior palate and incisors on a lower plane than those of *pelagius* or *finis*; or if placed end to end the tips of the nasals of the latter two always enter the nasal cavity of the other. Zygomatic breadth is little greater, and palatal foramina are slightly larger.

Measurements.—Ear of type, 24 mm. For other measurements see table, p. 74.

Specimens examined.—Twenty, all from the type-locality.

Remarks.—This race is somewhat intermediate between the preceding and following forms, in that the continuation of the white area to the foot is rather indistinct in several examples, while in two specimens (an adult and a subadult female) the under side of the fore limbs, a band across the chest, and the lower part of the hind limbs are pale ochraceous tawny.

31. *EPIMYS SURIFER ECLIPSIS*, subsp. n.

Type. Adult male (skin and skull), No. 1540/C.B.K. B.M. No. 15.11.4.125. Collected on Koh Kra Id., S.E. Siam, 16th December, 1914.

Characters.—Clay-coloured; white of lower side much reduced

in breadth, not very sharply margined, and not extending to the limbs. *Tail dark with a white tip.*

Colour.—A variable clay, the dorsal area everywhere much darkened by the bistre tips of the spines; this colour extending over the whole of the limbs, across the chest in the form of a broad gorget, the hairs of which have distinct grey bases, and over the entire muzzle, which is rather browner. White of under surface reduced to a comparatively narrow band running from the axillæ to groin, 25–30 mm, wide, and to an isolated patch confined to the throat. Fore and hind feet pale. Tail about the same length as head and body, dark for the basal two-thirds or three-fourths, the tip white, not sharply defined from the rest.

Skull and Teeth.—Generally resemble the mainland race, but with the nasals broader posteriorly, their outer margins straighter; the palatal foramina distinctly larger, being both longer and broader; anterior zygomatic plate broader; and the zygomatic breadth a little greater.

Measurements.—Ear of type, 24·5 mm. For other measurements see table, p. 74.

Specimens examined.—Nineteen from the type-locality.

Remarks.—Its dull colour, reduced white areas, and non-bicoloured tail render this race of *Epimys surifer* the most distinct known to me. All the Indo-Chinese forms here described are less brilliant in colour than any of the Malayan races of the *rajah-surifer* group, and their tendency to dullness, manifesting itself strongly in the island forms, culminates so notably in the Koh Kra animal, that, with its other characters in addition, one would readily accept it as a distinct species were it the inhabitant of a large land-mass and not of a little satellite islet.

32, *EPIMYS SURIFER TENEBROSUS*, subsp. n.

Type, Adult male (skin and skull), No. 1586/C.B.K. B.M. No. 15,114,121. Collected on Koh Klum, S.E. Siam, 18th December, 1914.

Diagnosis.—Like *E. s. eclipsis* above, but rather more darkened down the median line of the back. Below the white area rather broader, but not to the extent of the more typical forms, and extending a little way across the groin on to the thigh. Wrists very pale, but separated from the chest; white area of neck a little larger, but confined to the throat. Gorget clearer in colour and rather less distinct, the grey bases of the hairs not visible. Tail shorter than head and body; bicoloured with a white tip.

Skull and Teeth.—Like those of *E. s. eclipsis*, but the palatal foramina smaller, about the same length as the mainland form, but broader; the interorbital breadth markedly greater than either, and the anterior zygomatic root broader.

Measurements.—Ear of type, 24 mm. For other measurements see table, p. 74.

Specimens examined.—Eight from the type-locality.

Remarks.—This form is an intermediate stage between *connectens* and *eclipsis*. The former in isolated individuals is beginning to show the tendency towards increase in the yellow areas, while in the present animal this, as well as the darker coloration, is now well and constantly established. Both, however, still retain the normal bicolored tail.

It is interesting to note that in this small group of islands two opposite types of deviation occur: in *E. s. changensis* and *kutensis* the trend is towards an increase of the abdominal white area, while in this race and *E. s. eclipsis* it is the dorsal colour that has spread until it reaches a climax in the last form in conjunction with extreme dullness of tint and blackened tail.

33. *EPIMYS RATTUS*, subsp.

Mus rattus Bonhote, P. Z. S. 1900, p. 194; id., op. cit. 1901, vol. i. p. 56; Flower, op. cit. 1900, p. 361.

Mus rattus rufescens de Pousargues, Mission Pavie, Indo-Chine, Études Diverses, iii. p. 528 (1904).

Epimys rufescens Gyldenstolpe, Arkiv för Zoologi, Stockholm, Band 8, No. 23, p. 18 (1914).

I obtained at Ok Yam and Klong Yai a series of 13 rats, which are apparently indistinguishable from the common *Epimys rattus* of the Malay Peninsula, except that the white underparts more frequently assume a light silvery shade. I have had no opportunity of comparing them with *Epimys rattus robustulus* (Blyth) from Tenasserim, and therefore place them under the specific name. The tail is longer than the head and body and slightly paler below proximally; the feet are whitish.

One female from Ok Yam (No. 1797) is abnormal in having the tail slightly shorter than head and body and concoloured, the feet dark; the upper side blackish brown and the underparts of a colour intermediate between mouse-grey and neutral-grey.

With these I would associate four examples from Koh Chang Id.

From the two islands, Koh Mehsi East and West, series of 13 and 15 respectively were obtained. While showing much variability among themselves, all are apparently conspecific with the above. They range from melanotic individuals having backs strongly suffused with blackish brown to others having that surface of warm grizzled-brown, while underparts vary from white to grey.

This difference in colour is not a question of sex or age, for though juveniles generally (not invariably) have greyish undersides, yet these are by no means of so dark a shade as the extremes of the adults; neither do the darker-backed individuals always have darker underparts, though, again, this is generally the case.

The effect is to make the insular series much darker than the mainland one, but as this character is apparently transitory, it cannot be used for the purpose of differentiation.

Measurements.—See table, p. 75.

34. *EPIMYS RATTUS RANGENSIS*, subsp. n.

Type. Adult female (skin and skull), No. 1669/C.B.K. B.M. No. 15.11.4.208. Collected on Koh Rang Id., 22nd December, 1914.

Diagnosis.—Closely resembles the adjacent mainland normal form of *E. rattus*, but with the pelage a little coarser. Skull broader throughout—rostrum, palate, interpterygoid space, basi-occipital and zygomata—but with smaller palatal foramina, which do not reach a line joining the anterior ends of the molar rows. Nasals shorter and more truncate, so that when the skulls are reversed and resting on their upper surfaces the ends of the nasals are not visible from above.

Measurements.—Ear of type, 22 mm. For other measurements see table, p. 75.

Specimens examined.—Six from the type-locality.

Remarks.—Though differing very little bodily from the mainland animal, this race is easily separated from it on cranial characters, the short nasals and blunt muzzle being very distinct.

35. *EPIMYS RATTUS KLUMENSIS*, subsp. n.

Type. Adult female (skin and skull), No. 1596/C.B.K. B.M. No. 15.11.4.207. Collected on Koh Klum Id., S.E. Siam, 18th December, 1914.

Diagnosis.—Size larger and pelage coarser than the previous forms, with numerous long black piles on the rump. Colour above grizzled-brown and buff, darkest on the rump; below ivory-yellow, an indistinct greyish band along either side of the abdomen, separating it from the colour of the upper parts. Feet parti-coloured; tail considerably longer than body, relatively longer than any of the other local races.

Skull generally resembling that of the mainland animal, but more robust and with the nasals much narrower posteriorly and longer, prolonged well behind a line joining the anterior edges of the orbits.

Measurements.—See table, p. 75.

Specimens examined.—Five from the type-locality.

Remarks.—The larger size, relatively long tail, and long, posteriorly narrower, nasals clearly distinguish this race from either of the preceding; particularly the latter with its short square muzzle. It belongs, with the following forms, to the section of the *rattus* group consisting of large animals heavily sprinkled on the rump with long piles, and having large robust skulls, which includes the similar races of *Epimys pannosus* and *mara* Miller, *E. remotus* Robinson & Kloss, and is largely of insular habitat.

36. *EPIMYS RATTUS MAKENSIS*, subsp. n.

Type. Adult male (skin and skull), No. 1616/C.B.K. B.M. No. 15.11.4.211. Collected on Koh Mak Id., S.E. Siam, 19th December, 1914.

Diagnosis.—Closely resembles *E. r. klumensis* in colour, but with the under surface generally slightly silvered, especially in immature individuals. Size slightly larger, but tail considerably shorter. Nasals relatively rather narrower posteriorly, but skull otherwise apparently not differing from the mainland race except in greater size and robustness.

Measurements.—Ear of type, 23 mm. For other measurements see table, p. 75.

Specimens examined.—Fifteen from type-locality.

37. *EPIMYS RATTUS KRAENSIS*, subsp. n.

Type. Adult female (skin and skull), No. 1550/C.B.K. B.M. No. 15.11.4.203. Collected in Koh Kra Id., S.E. Siam, 16th December, 1914.

Diagnosis.—The largest of the known local forms of *E. rattus*, but with tail relatively shorter than in *E. s. klumensis*. Colour like *E. r. makensis*, but the grey edges of the abdomen more intense and skull with broader rostrum and nasals: anterior zygomatic roots heavier; the zygomatic plate broader and more convex, projecting further forwards; the plate laterally compressed and more vertical, resulting in a narrower infraorbital foramen.

Measurements.—See table, p. 75.

Specimens examined.—Twenty-one from the type-locality.

38. *EPIMYS GRISEIVENTER* Bonhote.

Mus griseiventer Bonhote, Fasciculi Malayenses, Zoology, Part 1, p. 30, pl. ii. fig. 3, and pl. iv. fig. 5 (1903).

A single example only of a rat that appears referable to this species was obtained on Koh Chang. As my camp was close to a village, which is a port of call for steamers, it is quite possible that the species has been introduced. The uniform upper surface, smoky-grey underparts tinged with buff, dark feet, and black tail distinguish it from forms of *E. rattus*.

Head and body 181 mm., tail 212, hind foot 34, ear 22.

39. *EPIMYS CONCOLOR* Bonhote.

Mus concolor Bonhote, P. Z. S. 1900, p. 195; id., op. cit. 1902, vol. i. p. 39; Flower, op. cit. 1900, p. 361; de Pousargues, Mission Pavie, Indo-Chine, Études Diverses, iii. p. 528 (1904); Gyldenstolpe, Arkiv för Zoologi, Stockholm, Band 8, No. 1, p. 18 (1914).

Numerous specimens of this little rat were brought to me by the children of Klong Yai for the sake of a cent. or two, but all were immature, and I only preserved five examples.

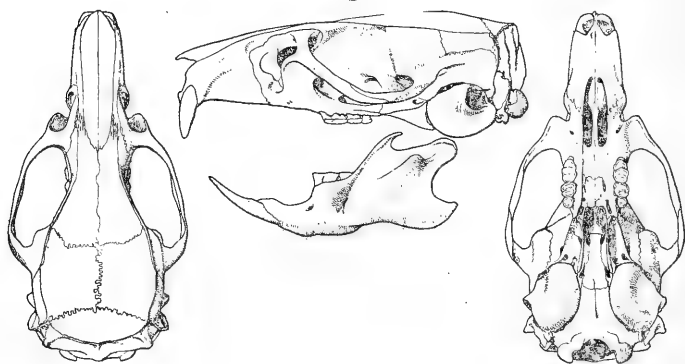
40. *EPIMYS BERDMOREI MAGNUS*, subsp. n. (Text-fig. 1.)

Type. Adult female (skin and skull), No. 1890/C.B.K. B.M. No. 15.11.4.157. Collected at Klong Menao, S.E. Siam, 12th January, 1915.

Characters.—A large form of *Mus berdmorei*, with smaller ears and tail considerably shorter than head and body, bicoloured with dark tip. Pelage of two elements:—slender, very flexible spines, with light bases and dark brown tips, and soft under-fur with neutral grey bases and dirty-white or drab tips. Mammaræ 3-2 = 10.

Colour.—General colour of the upper pelage, which is harsh but not stiff, clove-brown on the median dorsal area, lightening to mouse-grey on the cheeks, sides, and limbs; everywhere grizzled with the pale tips of the under-fur, and on the sides by the exposed pale portions of the spines also. When disturbed the neutral-grey basal colour contrasts sharply with the browner external tone. In certain lights a brilliant green sheen is visible from nape to rump. Under surface of body and limbs and the upper surface of the hands and feet white to the bases of

Text-figure 1.



Skull of *Epimys berdmorei magnus*.

the hairs; the white area extends to the extremities and the upper lip, but does not include the bases of the vibrissæ. Ears rounded and almost naked, a small white patch below the ear-opening. Tail bicoloured, only the basal three-fourths white beneath, the distal fourth entirely dark; somewhat thickly clad with short hairs, black on the dark, white on the white area, but no pencil; in the centre eleven rings of scutes to the centimetre.

Skull and Teeth.—I have been privileged to examine the skull of Blyth's *Mus berdmorei*, all that remains of the type which came from Mergui, Tenasserim; it lacks the bullæ and the posterior half of the cranium, while the teeth are only just beginning to show signs of wear. The Klong Menao individual, while otherwise resembling it, is considerably larger with apparently a relatively longer rostrum. The zygomatic plate is, however, actually narrower, as is also the anterior root of the zygoma, while the posterior root is more robust; the fronto-

parietal suture is less curved and the incisors are paler, being ivory-white with white tips, though they project in the notable manner of the type of *Mus berdmorei*; while the molars are of similar small size, and the rostrum is likewise elongated, with a straight or only slightly curved upper profile. No information is available as to the bullæ of the latter, but those of *E. b. magnus* are perhaps larger than are to be found in any eastern rat of equal size, being extremely dilated and kidney-shaped. Thomas, in the account of the skulls seen by him (see below), does not mention this very notable feature.

Measurements.—I give, in the form of a comparative table, the measurements of the present animal, of the type of *Mus berdmorei*, and such others as have been published of animals which have been allocated to the species*.

Collector's External Measurements, in millimetres.

	Siam.	Type.	Thagata.	Bhamo.	Manipur.
Head and body	210	circa 155	170	142	174
Tail	182	circa 150	...	163	172
Hind foot	38·5	35	32	35	36
Ear	19·5	...	20	22	...

Skull Measurements.

	Siam.	Type.	Thagata.	Manipur.
Greatest length	47			
Condyl-basilar length	43·2			
Basal length	42·2		36·4	
Palatal length	21·6	22·2	21·4	22·4
Palatal foramina	9·2	8·1	7·1	7·8
Diastema	10·1	14·0	12·9	14·1
Upper molar series	7·0	6·6	6·0	6·1
Length of nasals	19·2	16·0	14·0	16·0
Anterior breadth of nasals	4·8	4·2		
Interorbital breadth	7·1	6·6	6·8	7·0
Zygomatic breadth	24·0	21·5	21·8	21·5
Cranial breadth	17·0	16·5		
Interparietal breadth	14·7	13·7	10·3	
" length	8·1	...	4·0	
Extreme breadth between outer edges of infraorbital foramina	12·1	11·0	10·4	
Zygomatic plate	4·8	5·0	4·0	4·7
Extreme breadth between auditory meati	18·8			
Breadth of basioccipital at suture	3·5			

* Thomas, P. Z. S. 1886, p. 62, two unsexed specimens from Manipur; id., Ann. Mus. Civ. Genova, ser. 2a, vol. x, (xxx.), 1892, two females from Thagata, Tenasserim and Bhamo, Burma.

Remarks.—The above measurements show the much greater size of the eastern animal as compared with the western individuals, while the colour of the latter, given by Thomas as “clear slaty grey,” is also very different from the brownish tone of the other.

The type of *Epimys berdmorei* was described as being of about a foot in length, of which the tail was not quite half; hind foot $1\frac{3}{8}$ inches. Fur shortish, even, coarse and hispid, but not spinous, of one quality only. Incisors white. Tail rather more copiously clad than usual with short hairs. The upper side, originally given as grizzled-grey, unminged with rufous, was later stated by Blyth (*op. cit.* xxxii. p. 343) to be dull brown, which is in close agreement with the colour of the present animal.

The species is in no way related to *E. ferreocanus* Miller, of Peninsular Siam.

41. ACANTHION KLOSSI THOS.

A single porcupine of the *bengalensis* type was obtained on the mainland at Klong Yai.

It is remarkable how little information we have concerning *Hystrix bengalensis*. There is Blyth's original description* founded, I am able to state (thanks to authorities of the Indian Museum, Calcutta, who have lent me the type skull for examination), on a half-grown individual with incomplete dentition, supposed to come from the Sunderbunds. There is Jerdon, in the ‘Mammals of India,’ who borrowed from Blyth, and there is Anderson, who, in his ‘Zoological Researches,’ when treating of *H. yunnanensis*, gives (passim) a few fresh details, while Blanford, the latest author to deal with the species, had no material for examination when writing for the ‘Fauna of British India,’ and simply repeated Blyth's original description. Beyond this unsatisfactory literature no other details of topotypes seem available, and I am forced to supplement it by measurements of a skull from the Karen Hills given by Thomas in his paper on the Mammalia collected by Signor Fea in Burma and Tenasserim†.

The present example, while generally agreeing externally with descriptions of *Acanthion bengalensis* (Blyth), differs in the following respects:—The longest bristles of the crest are only 4 to 5 inches long, but are tipped with white for more than half their length; the white demi-collar is ill-defined on the middle of the throat; the quills are white with a dark band at their centres, rather than white and black with a more or less defined white tip, and the few long flexible quills are white throughout, lacking any dark middle band. Blyth's description, however, is hardly

* Journal Asiatic Soc. Bengal, vol. xx, p. 170 (1851).

† Ann. Mus. Civ. Genova, ser. 2 a, x. (xxx.), p. 37 (1892).

up to modern requirements for subspecific purposes, and is at best that of a young animal only.

Measurements of the skull are as follows; those in parentheses being of the Karen Hill animal referred to above:—Basal length, 119 (119) mm.; greatest breadth, 75·5 (68); mesial nasal length, 71 (64); anterior nasal breadth, 27 (29); posterior nasal breadth, 36·5 (40); length of naso-premaxillary suture, 43 (39); length of frontal suture, 31 (29); bregma to back of occipital crest, 42 (34); diastema, 36 (38); upper molar series, 31 (27); distance between outer corners of the two infraorbital foramina, 57 (53); height of nasion from centre of palate, 51 (51).

Thus the Siamese-Cambodian skull, while of the same length, is broader than the other; but the nasals are narrower throughout, though longer; the tooth-row is longer, as is that portion of the skull posterior to the bregma.

Other measurements that may be recorded are:—Median dorsal length of skull, 139 mm.; median nasal length, 71; median frontal length, 31; median parietal length, 18. Collector's external measurements:—Head and body, 835; tail, 115; hind foot, 93; ear, 45·5.

Having regard to these differences, together with geographical derivation, S.E. Siam being more than a thousand miles distant from the Sunderbunds, it seems possible that the eastern animal may eventually prove distinct; but until the mammal survey of India, now much curtailed, has been actively resumed again, and topotypes of *bengalensis* are available, nothing can be done. For the present, therefore, I content myself with the above remarks.

Pousargues, in Mission Pavie, Indo-Chine, Études Diverses, iii. p. 533 (1904), states that *H. bengalensis* does not extend eastward beyond Burma, but Gyldenstolpe (Arkiv för Zoologi, Band 8, No. 23, p. 20) has since recorded, under this name, a porcupine obtained by him in Northern Siam which appears to be intermediate in cranial dimensions between Fea's Tenasserim specimen and the present animal.

[At Mr. Kloss's request I have examined this skull, and it is referred to in my paper on *Acanthion klossi*, Ann. Mag. N. H. (8) xvii. p. 136, Jan. 1916.—O. Thomas.]

42. MONTIACUS MUNTJAK, subsp.

An immature male, with the posterior molars not fully up, was obtained on Koh Chang Id.

It is a very brightly coloured animal. Dorsal region and upper side of tail fulvous-chestnut becoming ochraceous on the under surface, limbs, base of ears, and sides of head. Forehead and front of pedicels tawny, top of muzzle brown. On the nape and the front of the lower limbs there is a scattering of blackish-brown hairs, which are in excess near the hoofs, particularly on the hind feet. A black line along the horn pedicels and the

facial rib. Chin and throat, inner side and posterior outer side of ears, axillary region, lower abdomen, inner side of thighs, under side of tail, back of lower fore limbs, and a small patch in front of the digits of each foot, white. Head and body, 980 mm.; tail, 185; hind foot, 291; ear, 105; height at shoulder, 610. Skull, greatest length, 203; greatest breadth, 81.

The horns, which are not yet differentiated from the pedicels, are tipped with velvet, and the distance in a straight line from the tips to the base of the pedicels on the inner side is 146 mm.

The Barking Deer of Siam was described by Gray (P. Z. S. 1861, p. 139) from a skull with deformed antlers as *Cervulus curvostylis*. Recently Mr. R. Lydekker, whose death all interested in game animals will much regret, has defined this race in the 'British Museum Catalogue of Ungulates,' vol. iv., as being of medium size (upper row of cheek-teeth $2\frac{3}{8}$ inches), general colour orange-tawny, fading to buffish on neck and underparts.

The present specimen is so young (milk premolars still in place) that, lacking other material from Indo-China for comparison, I have not applied any subspecific name for the present. The skull is remarkable for the reduced size and marked definition of the lachrymal pit, which is far smaller than any other which I have had the opportunity of inspecting, the upper edge being very sharp and the pit immediately within and above this notably concave. The vertical portion of the lachrymal is, further, much reduced in height.

43. CERVUS UNICOLOR, subsp.

Rusa peronii Gray, P. Z. S. 1861, p. 138 (?).

Cervulus cambojensis Gray, loc. cit. supra.

Cervus unicolor Flower, P. Z. S. 1900, p. 372.

Cervus aristotelis de Pousargues, Mission Pavie, Indo-Chine, Études Diverses, iii. p. 536 (1904).

Cervus unicolor equinus Gyldenstolpe, Arkiv för Zoologi, Band 8, No. 23, p. 30 (1914).

A form of Sambhar is represented in my collection by an immature female from Klong Yai, S.E. Siam. Height at shoulder, 760 mm.

The hairy frontlet and antlers of a deer collected by Mouhot in Cambodia was described by Gray (P. Z. S. 1861, p. 138), who then considered it to be a Muntjac, as *Cervulus cambojensis*, but was later identified by him as *Rucervus schomburgki*! (Brit. Mus. Cat. Ruminants, p. 76 (1872); Brit. Mus. Hand-list Ruminants, p. 145 (1873)). Lydekker, however, regards this specimen as belonging to *Cervus unicolor* (Brit. Mus. Cat. Ungulates, vol. iv. p. 79 (1915)), and if he is correct, and the Indo Chinese Sambhar prove to be distinct, it will have to be known as *C. u. cambojensis* Gray.

44. *TRAGULUS KANCHIL AFFINIS* Gray.

Tragulus affinis Gray, P. Z. S. 1861, p. 138.

Tragulus javanicus Flower, P. Z. S. 1900, p. 374.

Tragulus kanchil pierreii Bonhote, Ann. & Mag. Nat. Hist. ser. 7, vol. xi. p. 293 (1903); Lydekker, Brit. Mus. Cat. Ungulates, vol. iv. p. 291 (1915).

Tragulus kanchil de Pousargues, Mission Pavie, Indo-Chine, Études Diverses, iii. p. 535 (1904).

Tragulus kanchil affinis Bonhote, P. Z. S. 1907, p. 11; Gyldenstolpe, Arkiv för Zoologi, Band 8, No. 23, p. 29 (1914); Lydekker (partim).

A single female, with very worn teeth, from Ok Yam, Franco-Siamese Boundary.

This race is differentiated from that of the Malay Peninsula by the absence of any blackish nape-stripe; otherwise the coloration of the two is similar. The bony orbit appears to be a trifle larger.

Measurements.—Head and body, 438 mm.; tail, 70; hind foot, 110; ear, 35.5. Skull: greatest length, 89.5; greatest breadth, 43.

This form was first erected by Gray (P. Z. S. 1861, p. 138) upon material consisting of seven specimens from Cambodia collected by Mouhot. In the course of his description, he states that "a specimen of the species has been in the Museum as above named for many years: it is said to have come from Singapore; but that probably was only the port of transit." This remark can hardly be regarded as the citation of the type, so that the name *affinis* must be confined to the Indo-Chinese form, for it was further a *nomen nudum* until rendered available for use through being applied with description to the Cambodian animals specified therein.

In 1903, Mr. Bonhote (Ann. & Mag. Nat. Hist.) took the view that *affinis* should be referred to the Malayan animal with the specimen of dubious provenance for type, and redescribed a Cochin-Chinese example under the name *T. k. pierreii*. Later, however (P. Z. S. 1907, p. 11), he found reason to change his opinion, and accepted the name of *affinis* for the Indo-Chinese form.

Even the strict systematist, who holds that the first locality cited is that of the type-specimen, must, I think, accept this view, for the title of the paper in which this species is dealt with is "List of Mammals, etc., collected in Cambodia" and, unless otherwise specially excepted in the text, this locality has priority.

In the Brit. Mus. Cat. Ungulates, vol. iv., Lydekker appears to have overlooked the above facts. The unfortunate term "Lower Siam," applied by several describers of species to the northern half of the Malay Peninsula, *i. e.*, Peninsular Siam, has been the cause of much confusion to others who do not use their

atlases sufficiently *. Thus, Siracha in S.E. Siam, about 40 miles S.E. of Bangkok, is regarded by Lydekker as practically the type-locality of *T. rarus* Miller (= *T. k. affinis* of Lydekker), which came from Trang in Peninsular Siam, about 400 miles south of Bangkok. The outcome is that *T. k. affinis* is given a distribution from Pahang, Malay States, north to Moulmein in Tenasserim, and thence east to Annam, while *T. k. pierrei* Bonhote (= *T. k. affinis* Gray), which name is accepted by Lydekker, is supposed to extend from Lower Cochin-China west to Siam, thus making two subspecies of the same species exist side by side; whereas inter se *rarus* and *affinis* are two well-defined forms, the one spreading from the middle of the Malay Peninsula and the other from Cambodia, the line where they intergrade being still not clearly known.

In similar fashion Lydekker extends *T. javanicus napu* F. Cuv., of Sumatra, up the Malay Peninsula, from Selangor to Southern Tenasserim, and at the same time places in an intermediate position, Trang ranging southward, *T. j. canescens* Miller. While it is highly probable that the latter name will have to be regarded as synonym of the other, yet while the subspecies are excepted the allocation of specimens to them results in an impossible distribution.

45. *SUS CRISTATUS*, subsp.

Sus — (?) Gray, P. Z. S. 1861, p. 139.

Sus cristatus de Pousargues, Mission Pavie, Indo-Chine, Études Diverses, iii. p. 535 (1904).

An immature female, with posterior molars not up and one milk-incisor still present, was shot on Koh Chang Id.

The strongly-marked crest is tipped throughout with light isabelline, and there is a patch of clearly defined white bristles at the angles of the mouth, a number are scattered over the lower abdomen and in fewer quantity on the throat and chest. The prevailing colour is black, clear on the cheeks and shoulders, fore and lower hind limbs; but the forehead, sides, and thighs are annulated with buffy and white. The greater part of the inner surface of the ears is covered with white hairs, and the fringe along the edge is very short.

* To avoid similar confusion in future, I suggest the use of the following divisions for Siam:—

- (i.) Northern Siam: the mountainous country north of the Thoungyin River-mouth and the great bend of the Mekawng (about Lat. 18° N.)
- (ii.) Central Siam: the great plain, south of (i.), watered by the Menam and its tributaries and by the Bangpakong and the lower Mekawng and Petchaburi Rivers.
- (iii.) Western Siam: the hill country between the Menam plain and the Tenasserim Boundary, south to about Lat. 12° N.
- (iv.) Peninsular Siam: the Malay Peninsula south of (iii.) to the Protected Malay States.
- (v.) Eastern Siam: the "Korat Plateau" east of (ii.), drained by the tributaries of the Mekawng.
- (vi.) South-eastern Siam: the coastal country south of the Bangpakong basin and the Battambang-Cambodian frontier, drained by streams running into the Gulf.

(For fuller details see Journ. Nat. Hist. Soc. Siam, vol. i. part 4, 1915.)

The skull is remarkable for the antero-posterior length of the bullæ, which in this dimension are larger than those of full-grown animals from Peninsular Siam and about twice the length of those of *Sus jubatus*, a small race occurring on Terutau Island, off the west coast of that region and occupying a position with regard to it very similar to that of Koh Chang in respect of S.E. Siam. It is possible therefore that, when better material is available, this pig may prove to be a representative of a local race.

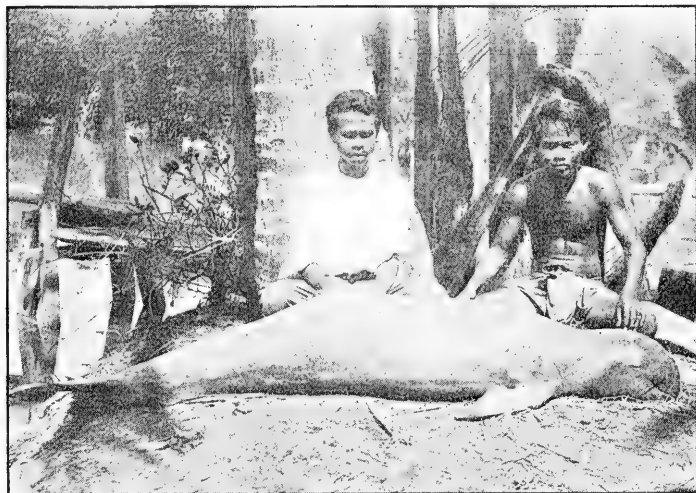
Though Blyth, in 1875 (Cat. Mamm. & Birds of Burma, p. 43), drew attention to differences in the Tenasserim animals, the common wild pigs throughout Eastern Asia were all regarded as typical *cristatus* until Miller separated the Peninsular Siamese and Tenasserim animal under the name of *S. jubatus* (Proc. U.S. Nat. Mus. xxx. p. 745, 1906), and it is this, or some allied form, that occurs in Southern Indo-China.

Head and body, 1110 mm.; tail, 190; height at shoulder, 610. Skull: greatest median length, 265; greatest breadth, 116; antero-posterior length of bullæ, 26.

46. ORCELLA BREVIROSTRIS (Owen). (Text-fig. 2.)

Orcella brevirostris de Pousargues, Mission Pavie, Indo-Chine, Études Diverses, iii. p. 546 (1904).

Text-figure 2.



Photograph of Porpoise (*Orcella brevirostris*) at Klong Yai, S.E. Siam.

A male example of this cetacean was brought to me by fishermen at Klong Yai on 6th December, 1914, but my preservatives being then nearly exhausted I only kept the skull.

Except that it had the profile of the head considerably less

swollen and convex, while the anterior edge of the pectoral fins was more curved and a neck more evident, it closely resembled the figure given by Anderson (Zool. Res. pl. xxv. fig. 4).

Colour slaty-leadен throughout; greatest length, 3660 mm. (7 ft.).

Skull : greatest length (condylo-basal), 286 mm. ; basal length, 260 ; palatal length, 141 ; greatest breadth, 202 ; rostral breadth, 77. Length of mandible, 225. The skull is asymmetrical, particularly in the region of the nasal openings ; but asymmetry seems to be the rule with this species.

Teeth, $\begin{smallmatrix} \text{R.16} & \text{L.15} \\ \text{R.12} & \text{L.13} \end{smallmatrix}$: all are worn down to mere flattened stumps and there are no signs of premaxillary teeth.

De Pousargues (*loc. cit. supra*) records a specimen from the Mekong River.

This species is very common along the Chantabun coast.

While sailing from Klong Yai to Klong Menao we saw, late in the afternoon of December 7th, numbers of white cetaceans between ourselves and the shore. They presented a most brilliant appearance with the low sun shining on them, but none came sufficiently near for details to be observed. They were, however, of large size, as big as the present species, and I imagine them to have been examples of *Sotalia sinensis* Flower.

EXPLANATION OF THE PLATE.

Map of the coast and islands of South-East Siam, showing the places at which collections were made by Mr. C. Boden Kloss.

TABLES OF MEASUREMENTS (in millimetres).—Measurements of hind feet are always exclusive of claws.

Hylobates pileatus (p. 29).

Locality.	Sex.	Head and body.	Hind foot.	Skull.				Collector's No.	Remarks.
				Greatest length.	Basal length.	Zygomatic breadth.	Maxillary tooth-row, excluding incisors.		
Klong Menao, S.E. Siam	♂	460	150	101	69	69	30	1859	Aged.
"	♂	465	150	102	73	69	33.5	1865	Adult.
"	♀	472	153	105.5	75	72.5	31.5	1874	Aged.
"	♂	485	153	105.5	73	73	30.5	1894	"
Lem Ngop,	♂	485	145	102	71	72.5	32	1901	"
Klong Menao,	♀	472	153	101	71	69.5	32	1889	"
Lem Ngop,	♀	465	147	101.5	71	67	31	1902	Adult.

Macaca irus (p. 31), *Presbytis germani* (p. 32), *P. g. mandibularis* (p. 32).

Species and Locality.	Sex.	Total length.	Tail from angle with back.	Nose to vent.	Tail from vent to tip.	Hind foot.	Skull.				No.	Remarks.
							Greatest length.	Basal length.	Zygomatic breadth.	Maxillary tooth-row, excluding incisors.		
<i>Macaca irus.</i>												
Koh Kut Id., S.E. Siam	♂	902	483	...	...	118	112	80	77	40	1688	Adult.
"	♂	935	485	...	...	118	111	80	78	39	1757	Aged.
"	♂	940	...	455	485	123	108.5	75	77.5	37	1722	Adult.
"	♀	842	...	410	432	109	100	69	69.5	32.5	1723	Aged.
"	♀	844	452	...	...	108	93	62.5	67.5	32	1689	"
<i>Presbytis germani.</i>												
Klong Yai, S.E. Siam	♂	1300	755	...	...	160	106	80	78	36	1839	Adult.
<i>P. g. mandibularis.</i>												
Koh Chang Id., S.E. Siam	♂	1260	720	560	...	160	99.5	72.5	77	35	1433	Aged.
"	♀	590	...	590	800	156	100	72	75	32.5	1483	"
"	♀	1305	795	560	...	152	97	71	72	32.5	1435	Adult.
"	♀	1285	780	530	...	157	93	69	74.5	33	1434	"

Tupaia concolor (p. 36), *T. c. sinus* (p. 36)

Species and Locality.	Sex.	Head and body.	Tail.	Hind foot.	Skull.							No.	Remarks.	
					Greatest length.	Basal length.	Palatal length.	Upper molar row.	Tip of pre-maxillaries to lachrymal notch.	Rostral breadth at diastema.	Inter-orbital breadth.			Zygo-matic breadth.
<i>Tupaia concolor.</i>														
Ok Yam, Franco-Siamese Boundary, on coast.	♀	195	184	41	49.7	42.3	24.8	14.2	19	6.8	14.1	25.5	1803	Adult.
"														
Klong Yai, S.E. Siam	♂	192	180	41.5	52.3	44.6	27	15.1	20	7.3	14.5	27	1812	Aged.
"	♂	195	195	45	53	46.8	28.1	16.3	21	6.9	14.9	27.1	1824	Adult.
"	♂	200	200	45	54.5	47.6	28.6	16.2	21.8	8	15	28	1825	Aged.
"	♀	195	197	45	53	46	27.5	16.1	20.4	7	14.2	26.1	1826	Adult.
"	♀	193	198	44.5	53.4	46.8	28	15.4	21	7.2	14.9	27	1828	"
"	♀	191	200	...	52	45.4	27	16	20	7	13.8	25.8	1840	"
"	♀	195	170	46.5	52.3	45.5	28.5	16.1	22.2	7.4	14.2	26.9	1841	Aged.
Klong Menao, S.E. Siam	♀	189	180	45.5	51.3	44.7	27.7	16	22.3	7.2	15	26.5	1876	Adult.
"	♂	185	185	45	52.5	44.8	27.3	15.8	22.2	7.2	14.5	26.6	1888	"
<i>T. c. sinus.</i>														
Koh Chang Id., S.E. Siam	♂	187	173	44	53.3	47	28.3	16	21.7	7.0	14.8	26.8	1402	Adult.
"	♀	185	165	42.5	49.8	43.3	26.2	15.2	21.7	6.7	13.6	24	1403	"
"	♂	180	170	42.5	50.3	43.3	26.8	15.3	22	6.9	14	25	1419	"
"	♀	180	171	41	50.5	43.7	27	15.2	21.8	7.3	14.8	25.2	1420	"
"	♂	183	167	43	51	44	27.2	15.2	22.2	7.0	14	25	1422	"
"	♀	176	168	43	50	43.4	26.9	15.9	22	6.9	13.9	24.1	1506	"

Type.

Locality.	Sex.	Head and body.	Tail.	Hind foot.	Skull.								No.	Remarks.
					Greatest length.	Condylor-basal length.	Palatal length.	Upper molar row.	Tip of pre-maxillaries to lacrymal notch.	Breadth of brain-case.	Inter-orbital breadth.	Greatest breadth.		
Klong Menao, S.E. Siam	♂	130	127	30	36.6	...	19.5	12.7	14.7	15	11.4	20	1861	Adult.

Ratufa melanopepla leucogenys (p. 43), *R. m. sinus* (p. 44).

Species and Locality.	Sex, and body.	Tail.	Hind foot.	Skull.							No.	Remarks.		
				Greatest length.	Condylor-basal length.	Palatal length.	Diastruma.	Upper molar row.	Inter-orbital breadth.	Zygomatic breadth.			Median nasal length.	
<i>Ratufa melanopepla leucogenys</i> .														
Leam Ngoy, S.E. Siam	♀	370	435	79	71	60.5	27	16	14	26.5	46	22	1912	Adult.
"	♂	360	435	80	73	61	27.7	16	14.2	29.5	44	25	1900	"
"	♂	345	450	79	71	55.5	26.3	14.7	14	26.7	44.5	23	1913	"
<i>R. m. sinus</i> .														
Koh Kut Id., S.E. Siam	♀	377	425	79	73	61.2	28	16.3	14.2	28.3	46	24.3	1733	Adult.
"	♀	380	450	79	72	60.7	27.5	15.5	14.2	30	46	25.2	1734	"
"	♂	370	435	79	71.5	61	27.2	16.2	14	28	...	24	1781	"
"	♂	360	427	75	72.7	59.5	27	15.5	14	23.2	44.5	24.5	1779	"
"	♀	355	435	77	71.5	60	27	15.5	14	28	45	25.8	1775	"
"	♂	355	415	75	71	59.8	27	16	14	28.5	44	24	1774	"

Species and Locality.	Sex.	Head and body.	Tail.	Hind foot.	Skull.							No.	Remarks.	
					Greatest length.	Condylar basal length.	Palatal length.	Diastema.	Upper molar row.	Inter-orbital breadth.	Zygomatic breadth.			Median nasal length.
<i>Sciurus f. cinnamomeus.</i>														
Ok Yam, Franco-Siamese Boundary, on coast.	♂	225	215	51	55	46.5	22.2	12.1	10.3	20.6	34.2	16	1790	Adult.
"	♀	225	210	50.5	55	47	22.2	12.2	10.1	21	33.5	16	1792	Aged.
"	♂	227	218	53	55.6	47	22.3	12.3	10.3	21.5	32.5	16.3	1801	Adult.
Klong Yai, S.E. Siam	♂	230	195	52	56.1	48.2	23.2	12.8	10.3	20.4	34.6	16	1823	"
"	♂	230	215	51.5	55	47	22.1	12.6	10.4	20.1	32.7	15.3	1848	"
Klong Mennaw, S.E. Siam	♂	230	215	55	55.5	48	23.8	12.8	10.6	20.4	32.3	16.7	1858	"
"	♀	225	230	52	55.8	48	21	13	10.3	19.5	33.3	16.5	1883	"
Len Ngop,	♂	223	202	50.5	53	45.8	22	12	10.3	21.2	33	16.7	1907	Aged.
"	♂	220	220	50.5	54	46.7	23	12.1	10.8	20	33	15.6	1908	Adult.
"	♂	227	...	51.5	54.3	46	22.4	12.2	10.5	19.9	32.5	15.8	1910	"
<i>S. f. frandseni.</i>														
Koh Chang Id., S.E. Siam	♂	220	210	50	54	46.6	23	12.1	10.4	18.8	32.2	16.2	1450	Adult.
"	♀	220	...	51	54.3	46	22.5	12.2	10	19.8	32	16	1461	"
"	♂	224	186	49	52.6	45	22	12	10.3	18.4	31.5	15.7	1462	"
"	♀	225	205	50.5	55	46.4	22	12.2	10	20	32.8	15.3	1467	"
"	♂	222	200	49.5	56	47	23	12.8	10.4	20.3	33	17	1470	"
"	♂	231	214	51	56.3	47	23	12.9	10.5	19	32	16.6	1486	"
"	♂	233	212	52	56	47.9	23	13	10.3	19.3	32	16.5	1487	Aged.
"	♀	235	215	53	57	48	23.5	12.9	10.9	20	33.1	16.9	1502	Adult.
"	♂	223	204	51	56	46.8	22.5	12.8	10.3	20.5	33	16.7	1504	"
"	♀	217	205	50	...	46	22.2	12.4	10.5	19.2	32.3	...	1505	"
<i>Sciurus albivexilli.</i>														
Koh Kut Id., S.E. Siam	♂	230	210	53	57	49	24.3	13	10.8	20	33	16.3	1705	Adult.
"	♀	230	...	52	56.3	47.7	23.7	13	11	20	32.8	17.7	1706	Aged.
"	♂	224	210	51	55	47	23	12.7	10.8	19.4	32	14	1724	Adult.
"	♂	233	207	52	55	47	23.5	12.8	10.8	19.3	33	16.3	1725	"
"	♂	240	210	51.5	55.6	48	23	13	10.3	20	32	16.8	1728	Aged.
"	♂	222	196	51	55	47.8	24	12.6	11	19.6	32.6	15	1730	Adult.
"	♀	227	195	49	55	47.3	23	12.8	10.9	19.4	33	15.5	1735	Aged.
"	♂	230	220	51	55.3	47.8	23.2	12.4	11.2	20	32.7	16	1770	Adult.
"	♂	230	210	51	56	47.3	23.2	12.2	10.3	21	34.1	17	1778	"
"	♂	227	210	52	55	47.1	23.2	13	10.5	19.8	33	16.7	1785	"

Species and Locality.	Sex.	Head and body.	Tail.	Hind foot.	Skull.								No.	Remarks.
					Greatest length.	Condylor-basal length.	Palatal length.	Diastema.	Upper molar row.	Inter-orbital breadth.	Zygomatic breadth.	Median nasal length.		
<i>Menetes berdmorei mouhotii.</i>														
Ok Yam, Franco-Siamese Boundary, on coast	♀	215	150	45	...	...	...	...	98	138	28	17	1795	Aged.
"	♀	190	140	42	53.3	44.5	25	14.4	10.4	138	28.8	17	1811	"
"	♂	200	...	43	53.7	45.2	25	15	10.3	132	28.8	16.7	1816	"
Klong Yai, S.E. Siam	♂	203	152	45	50.3	43.8	23.3	13	10.2	130	27	...	1821	Adult.
"	♀	190	...	43	50.7	...	24.1	13.8	10	12.8	26.8	16.3	1838	"
"	♂	198	137	43.5	51	44	24.6	14	10	12.8	28	15	1842	"
"	♀	186	150	42	...	43	23.5	13.5	10.3	13	...	14.6	1834	"
Klong Mennaw, S.E. Siam	♂	205	...	42	52	44	23.5	13.7	9.7	133	27.5	15	1897	Aged.
Lem Ngop,	♀	197	127	41	51.3	44	24	14	9.7	121	27	14.2	1898	"
"	♂	202	138	42	51.2	44	23	13.8	10	13	28.5	14.5	1905	Adult.
<i>M. b. umbrosus.</i>														
Koh Chang Id., S.E. Siam	♂	193	127	41	50.7	43	23.2	13	10.6	13	26.6	14.2	1446	Adult.
"	♀	203	...	41	52.2	44.1	23	13.7	10.7	13	27.5	16.4	1448	Aged.
"	♂	193	132	41	50.7	43.2	23.5	13	10.4	12	26.2	15.5	1449	Adult.
"	♀	187	115	43	48.2	42.2	22.6	12.4	10.2	12.8	26.5	14	1480	"
"	♂	191	146	41	50.0	42.5	24	13	10.5	13	25.5	16	1488	"
"	♀	180	...	40.5	...	...	24	13	10.3	13	25.5	14.7	1482	"
<i>M. b. rufescens.</i>														
Koh Kut Id., S.E. Siam	♂	195	127	41	51	44	24	13.2	10.6	13	27.2	16	1685	Adult.
"	♀	205	...	43.5	54	46.3	24.6	13.8	10.6	14.3	29	15.1	1720	Aged.
"	♂	202	...	41	52	45	25.6	14.8	10.2	13.5	28	15	1737	"
"	♀	195	130	39	51.4	45	25	14	9.8	14.4	27.5	15.1	1739	"
"	♂	205	120	42	52	45.2	25	14	11	13.2	28	14.7	1740	"
"	♀	217	130	43	55	47	26	14.8	11	14	29	16.7	1759	"
"	♂	202	118	40.5	51	43.8	24.6	13.2	11.2	13.1	27.2	14.3	1761	Adult.
"	♀	206	129	38	51.7	44.7	24.6	13.6	10.9	13	27	16.3	1771	Aged.
"	♂	206	127	40	51.2	44	24	12.7	11.5	12.7	27.3	14	1772	Adult.
"	♀	194	141	41	51	44.1	25	13	11	13.5	27.2	14.7	1773	"

Tamniops rodolphii (p. 47).

Locality.	Sex.	Head and body.	Tail.	Hind foot.	Skull.						No.	Remarks.		
					Greatest length.	Ordylo-basal length.	Palatal length.	Diastema.	Upper molar row.	Inter-orbital breadth.			Zygomatic breadth.	Median nasal length.
Lem Ngop, S.E. Siam	♂	118	102	29	32.6	26.8	13	7	5.5	12.5	21.0	8.5	1903	Adult.
"	♀	115	120	29.5	32.0	26.6	12.2	6.8	5.5	11.9	20.1	8.0	1904	"

Epimys jerdoni marinus (p. 50).

Locality.	Head Sex. and body.	Tail.	Hind- foot.	Skull.						No.	Remarks.		
				Greatest length.	Condylor- basal length.	Diastema.	Upper molar. row.	Palatal foramina.	Median nasal length.			Combined nasal breadth.	Zygomatic breadth.
Koh Chang Id., S.E. Siam.....	144	156	26.5	37.0	30.4	9.2	6.1	6.2	13.4	4.1	16.3	1414	Adult.
"	152	168	28	37.9	31.8	9.8	6.0	6.0	14.0	4.5	17.2	1432	Adult.
"	150	170	26.5	37.9	31.8	9.7	6.1	6.7	13.5	4.3	17.0	1455	Adult.
"	150	...	27	37.6	32.0	9.9	6.1	7.0	13.7	4.3	16.8	1497	"
"	141	173	26	38.2	32.0	10.1	6.0	6.0	14.8	4.4	16.6	1489	"
"	145	...	26	36.5	30.4	9.6	5.8	6.1	13.3	4.2	16.4	1677	"
Kot Kut Id.,	147	184	28.5	37.2	31.5	9.9	6.1	6.5	13.4	4.3	16.2	1702	"
"	147	179	27.5	36.0	30.2	9.9	5.9	6.7	12.4	4.1	...	1704	"
"	146	170	27	36.4	30.3	9.2	5.9	6.1	13.0	4.0	16.3	1716	Adult.
"	146	156	28	36.4	31.0	9.6	6.0	6.7	13.3	4.2	16.0	1784	Aged.

Epimys swirfer subsp.

Race and Locality.	Sex.	Head and body.	Tail.	Hind foot.	Skull.							No.	Remarks.
					Greatest length.	Condylar basal length.	Diastema.	Upper molar row.	Length palatal foramina.	Median nasal length.	Breadth combined nasals.			Zygomatic breadth.
<i>Epimys swirfer fuis</i> (p. 51).													
Ok Yam, S.E. Siam.....	♀	173	179	39	44.2	36.5	10.9	6.9	6.2	17.0	4.5	20	1799 Adult.
Klong Yai, ".....	♀	178	187	37	44.2	37.5	12.4	6.9	6.0	16.8	4.7	20.3	1829 Aged.
Klong Menao, S.E. Siam	♂	210	186	40	48.0	41.1	13.6	7.0	6.8	19.0	5.1	20.3	1864 " "
" " ".....	♀	174	183	36	...	37.8	12.7	6.4	6.0	...	5.2	20	1873 Adult.
" " ".....	♂	190	193	39	47	38.7	12.5	7.0	6.2	18.3	5.0	20	1885 Aged.
<i>Epimys swirfer changensis</i> (p. 52).													
Koh Chang Id., S.E. Siam.	♂	182	178	37	44.3	36.5	11.7	6.9	6.2	17.0	4.8	20.1	1417 Adult.
" " ".....	♂	191	175	37.5	45.5	38.6	12.8	6.6	6.5	18.2	5.9	20	1427 Aged.
" " ".....	♀	185	170	35.5	45.0	37.4	12.4	7.1	6.3	17.2	5.1	20	1428 Adult.
" " ".....	♂	177	175	38	44.3	37.4	12.4	6.4	6.0	17.4	4.9	20.3	1438 Aged.
" " ".....	♂	172	172	38.5	45	38.2	12.2	7.0	6.7	17.8	5.3	20.9	1492 " "
<i>Epimys swirfer kutensis</i> (p. 52).													
Koh Kut Id., S.E. Siam.....	♂	178	167	35	44	37	12	7.0	6.0	18.2	4.7	20	1695 Aged.
" " ".....	♂	194	178	38	45.9	38.4	12.9	7.1	6.3	18.5	4.9	21.3	1710 " "
" " ".....	♂	188	181	38	46	38.2	12.6	7.0	6.7	18.0	5.2	20.6	1712 " "
" " ".....	♂	185	171	38.5	45.5	38.7	13.0	7.0	6.2	18.5	5.5	20.7	1750 " "
" " ".....	♂	180	168	35	43.0	36.5	12.1	6.9	6.1	17.4	4.5	20	1763 " "
<i>Epimys swirfer pelagius</i> (p. 53).													
Koh Rang Id., S.E. Siam	♂	198	185	39.5	47	39	12.9	7.1	6.1	18.7	5.0	21	1642 Aged.
" " ".....	♂	200	179	40	47.8	39.8	13.1	7.4	6.5	19.0	5.0	21	1659 Adult.
" " ".....	♂	198	179	38.5	46.8	38.5	13.1	7.0	6.2	18.0	5.3	21.6	1660 " "
" " ".....	♀	192	168	38	46	38.5	12.6	7.1	6.3	18.0	5.2	20.3	1664 Aged.
" " ".....	♀	187	163	36	44.2	37	12.2	6.7	6.1	17.6	4.9	20.6	1665 Adult.

Race and Locality.	Sex.	Head and body.	Tail.	Hind foot.	Skull.							No.	Remarks.	
					Greatest length.	Condylo-basal length.	Diastema.	Upper molar row.	Length palatal foramina.	Median nasal length.	Breadth combined nasals.			Zygomatic breadth.
<i>Epimys surifer connectens</i> (p. 53).														
Koh Mak Id, S.E. Siam	♂	197	179	39	46.4	39.2	13	7.2	6.5	18.6	5.5	21.1	1603	Adult.
"	♀	198	169	38.5	45	39.1	13	7.0	7.0	17.6	5.7	21.5	1610	"
"	♂	195	170	36	46	39.6	13.2	7.1	6.9	19.3	5.5	22.0	1612	Aged.
"	♀	200	163	37	46.7	39.1	13	7.0	7.1	19.6	5.8	22.0	1613	Adult.
"	♂	191	190	38	47	39.4	13.6	6.9	6.7	19.8	5.4	22.0	1632	"
<i>Epimys surifer eclipsis</i> (p. 53).														
Koh Kra, S.E. Siam	♀	201	197	39	46	39	13	6.9	7.0	18.8	5.0	21	1543	Adult.
"	♀	200	180	37.5	45.1	38.6	12.8	6.9	7.1	18.9	4.9	21.2	1559	"
"	♀	191	177	39	45.1	38.9	12.9	7.0	7.2	18.0	4.9	20.8	1561	"
"	♂	194	187	39	46	39.3	13	7.2	7.0	19.0	5.0	20.5	1564	"
"													1540	"
<i>Epimys surifer tenebrosus</i> (p. 54).														
Koh Klum, S.E. Siam	♂	196	176	41	46.7	39.8	13.3	7.0	6.2	18.8	5.0	20.4	1586	Aged.
"	♂	202	180	39	47.2	39.6	13.2	6.9	6.3	19.3	5.2	20	1587	"
"	♂	197	190	40	47.9	40	13.7	7.0	6.2	19.1	5.1	20.6	1588	Adult.
"	♀	192	169	38	47	39.3	13.3	6.9	6.0	19.2	5.1	20	1591	Aged.
"	♀	191	177	37.5	46.6	39	13	7	6.2	18.8	4.9	21	1593	Adult.

Subspecies and Locality.	Sex. and body.	Head Tail.	Hind foot.	Skull.						No.	Remarks.			
				Greatest length.	Condylar basal length.	Diastema.	Upper molar row.	Length palatal foramina.	Median nasal length.			Breadth combined nasal.	Zygomatic breadth.	
<i>E. rattus</i> , subsp. (p. 55).														
Klong Yai, S.E. Siam	♂	177	196	36	43.2	38.0	12.0	7.1	8.2	15.8	4.7	20.0	1833	Adult.
"	♂	160	160	31	41.5	35.8	10.9	7.0	7.3	14.8	4.2	19.1	1834	"
"	♂	173	173	32	42.8	37.0	11.2	6.8	8.0	15.2	4.4	19.1	1843	"
"	♂	164	...	33	42.1	36.0	11.2	7.7	8.0	15.0	4.7	20.0	1844	Aged.
"	♂	170	177	33	42.0	37.7	11.8	7.5	8.0	14.4	4.4	19.5	1855	"
Koh Chang Id., "	♂	166	185	31	40.0	35.5	10.7	7.2	7.3	14.8	4.7	19.2	1413	Adult.
Koh Melsi West Id., S.E. Siam	♂	170	184	32.5	42.4	37.5	12.0	7.2	8.5	16.1	4.8	20.2	1531	Aged.
"	♂	179	182	32	42.0	37.6	11.3	7.2	8.4	16.1	4.9	20.1	1533	"
Koh Melsi East Id., "	♂	173	182	35.5	41.7	37.0	11.6	7.5	8.0	15.3	4.5	19.7	1515	"
"	♂	167	171	31	41.4	36.0	11.0	7.0	8.0	15.4	4.7	19.9	1519	"
<i>E. rattus rangensis</i> (p. 56).														
Koh Rang Id., S.E. Siam	♀	186	194	35.5	41.0	37.3	12.0	7.0	7.7	14.7	4.7	20.5	1653	Aged.
"	♀	180	184	35	41.2	37.5	11.5	7.0	7.2	14.3	5.0	19.5	1668	Adult.
"	♀	202	210	36	42.5	39.3	12.8	7.0	7.7	15.0	5.2	21.6	1669	Aged.
"	♀	179	186	36.5	40.2	36.7	11.9	6.8	7.1	13.6	4.8	19.8	1670	Adult.
<i>E. rattus klamensis</i> (p. 56).														
Koh Klum Id., S.E. Siam	♂	190	236	37	43.5	38.6	11.5	8.0	7.6	17.1	4.8	21.1	1584	Adult.
"	♂	186	233	36.5	44.1	39.1	12.0	8.1	7.9	17.4	4.7	21.5	1595	"
"	♂	191	235	37	45.4	40.2	12.7	8.5	7.7	17.6	5.0	22.4	1596	Aged.
"	♂	197	230	38	...	...	12.4	8.7	7.8	18.0	5.2	22.4	1598	"
<i>E. rattus makensis</i> (p. 56).														
Koh Mak Id., S.E. Siam	♂	191	222	36	44.2	39.5	12.2	7.1	8.3	17.0	5.3	22.1	1615	Adult.
"	♂	205	210	38	45.5	41.0	12.7	7.3	9.0	17.9	5.1	22.2	1616	"
"	♂	202	213	38	45.5	40.0	12.3	7.6	8.5	17.5	4.9	23.0	1618	"
"	♂	202	205	36	45.0	40.1	12.4	7.8	9.5	16.3	5.0	23.1	1622	"
"	♂	197	217	35	47.0	41.1	13.0	8.1	9.7	17.8	5.2	22.8	1639	"
<i>E. rattus kraensis</i> (p. 57).														
Koh Kra Id., S.E. Siam	♂	213	...	38.5	47.3	42.0	13.3	8.6	9.1	17.8	6.0	24.0	1546	Aged.
"	♂	211	228	37	46.6	40.1	12.5	8.1	8.9	17.2	5.3	23.5	1550	Adult.
"	♂	215	...	38	47.0	40.4	12.4	8.5	8.9	18.2	5.7	23.0	1558	Aged.
"	♂	194	240	36	45.2	39.2	12.8	7.5	8.6	18.0	5.2	22.0	1573	Adult.
"	♂	218	229	37	46.0	39.3	12.2	8.0	8.6	18.1	...	22.5	1575	"

3. Report on the Deaths which occurred in the Zoological Gardens during 1915, together with a List of the Blood-Parasites found during the Year. By H. G. PLIMMER, F.R.S., F.Z.S., Professor of Comparative Pathology in the Imperial College of Science and Technology, London, and Pathologist to the Society.

[Received January 17, 1916 : Read February 8, 1916.]

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On January 1st, 1915, there were 733 mammals, 2073 birds, and 371 reptiles in the Zoological Gardens; and during the year 280 mammals, 1167 birds, and 237 reptiles were admitted, making a total for the year of 1013 mammals, 3240 birds, and 608 reptiles.

During 1915, 280 mammals, 706 birds, and 179 reptiles have died: that is, a percentage of 27·6 for mammals, 21·7 for birds, and 29·4 for reptiles.

Out of the total deaths for the year, 1165 in all, 378 occurred in animals which had not been six months in the Gardens: that is, about one-third of the total number. It has been found that after six months' residence in the Gardens the death-rate of the animals falls rapidly; so it is assumed that by this time the new arrivals have got over their journeys, or have died from any diseases they may have brought with them, or have got quite used to their new environment. Of these 378 animals 90 were mammals, 200 were birds, and 88 were reptiles; and if these be deducted from their respective totals, the death-rate percentage will come out as 18·6 for mammals, 15·6 for birds, and 14·9 for reptiles.

The following Tables show in outline the facts which have been ascertained. Table I. summarizes the actual causes of death in the three groups specified. Under Reptiles are included Amphibia.

TABLE I.—Analysis of the Causes of Death.

Diseases.	Mammals.	Birds.	Reptiles.	Reference to Notes following.
1. <i>Microbic or Parasitic Diseases.</i>				
Tuberculosis	6	60	2	1
Mycosis	10	32	6	2
Pneumonia	48	70	34	3
Septicæmia	5	...	1	4
Abscess .....	...	1	...	5
Pericarditis .....	...	1	...	
Peritonitis	1	2	...	6
Empyema	5	...	...
Bronchiectasis	1	...	...	7
Pyelitis	1	...	...

TABLE I.—Analysis of the Causes of Death (*continued*).

Diseases.	Mammals.	Birds.	Reptiles.	Reference to Notes following.
1. <i>Microbic or Parasitic Diseases (cont.)</i>				
Cystitis	1	...	...	8
Hæmogregarinosis .....	...	...	1	9
Coccidiosis	2	...	...
Saccharomycosis .....	...	...	3	
Toxoplasmosis .....	...	...	1	10
Syngamus .....	...	6	...	
2. <i>Diseases of Respiratory Organs.</i>				
Atelectasis	1	...	...
Bronchitis	10	...	...	} 11
Congestion of lungs	13	130	11	
Broncho-pneumonia	34	...	...
3. <i>Diseases of the Heart.</i>				
Pericarditis .....	...	1	...	
Degeneration of heart-muscle ..	...	1	...	
4. <i>Diseases of the Liver.</i>				
Hepatitis .....	...	1	...	
Cirrhosis	1	...	...
Fatty degeneration .....	...	4	1	
5. <i>Diseases of the Alimentary Tract.</i>				
Gastritis	1	1	2	
Gastric ulceration	4	...	...
Gastro-enteritis	11	1	6	} 12
Enteritis	25	150	8	
Intestinal obstruction	2	1	...	
Intussusception	4	...	...
6. <i>Diseases of Urinary and Generative Organs.</i>				
Nephritis	40	81	6	13
Cystitis	1	...	...
Salpingitis .....	...	8	1	
Retained placenta	1	...	...
Atrophy of uterus	1	...	...	14
7. <i>Various.</i>				
Carcinoma	2	...	...	15
Sarcoma	3	...	...	16
Adenoma	1	...	...
Angioma	1	1	...	
Chloroform poisoning	1	...	...
Osteomalacia .....	...	1	...	
Injuries discovered <i>post-</i> } <i>mortem</i>	1	2	...	

Besides those tabulated above,

38 mammals, 113 birds, 4 reptiles, were killed by order or
by companions,
1 ,, 6 ,, 51 ,, died from malnutrition
or starvation,
4 ,, 31 ,, 41 ,, were too decomposed
for examination.

In Table I. an analysis is made of the immediate causes of death, but in nearly every case the animals were found to be suffering from other lesions as well. Table II. summarizes these other diseases from which the animals were suffering; and if this Table be taken in conjunction with Table I., a much more accurate estimate of the amount of disease in the Gardens will be arrived at.

TABLE II.—Secondary Diseases found in the animals tabulated in Table I.

Diseases.	Mammals.	Birds.	Reptiles.	Reference to Notes following.
Tuberculosis .....	...	13	1	
Mycosis .....	...	2	...	
Pneumonia	5	...	1	
Pericarditis	5	...	...
Peritonitis	2	...	...
Abscess .....	...	1	1	
Pyorrhœa	2	...	...
Hydatids	2	...	...
Worms	1	2	2	
Malaria	1	8	...	17
Filaria	2	6	1	18
Leucocytozoa .....	...	3	...	19
Scabies	2	...	...
Suppuration	2	...	...
Necrosis	3	...	...
Amœbic infection .....	...	...	4	20
Hæmogregarines .....	...	...	17	21
Bronchitis	8	...	...
Broncho-pneumonia	8	...	...
Congestion of lungs	23	157	5	
Edema of lungs	1	134	9	
Hydrothorax	1	...	...
Dilated heart	2	7	...	
Atheroma	5	4	...	
Aneurism	2	...	...	22
Pericarditis .....	...	11	...	
Degeneration of heart-muscle	4	8	...	
Hydropericardium .....	...	2	...	
Hepatitis .....	...	6	2	
Fatty degeneration of liver	17	45	12	23
Cirrhosis	5	1	...	
Gastritis	2	...	1	
Gastric ulceration	14	...	...	24
Gastro-enteritis	5	...	1	
Enteritis	41	109	6	
Intussusception	2	...	...
Atony of intestine	1	...	...	25
Nephritis	43	81	4	
Stone	1	...	...	26
Pregnancy	1	...	...
Salpingitis .....	...	1	...	
Sarcoma	1	...	...	27
Ascites	3	4	2	
Hæmorrhage	1	...	...
Spinal curvature	1	...	...
Rickets	17	...	...
Osteomalacia .....	...	1	...	
Injuries	4	9	...	

Table III. shows, in still further detail, the distribution of the immediate causes of death amongst the various orders of mammals.

TABLE III.—The Distribution of Diseases causing Death amongst the principal Orders of Mammals.

Diseases.	Primates & Insectivora.	Carnivora.	Rodentia.	Ungulata.	Edentata.	Marsupialia.
Tuberculosis	2	...	1	3	...	...
Mycosis .....	...	...	1	3	...	6
Pneumonia	16	7	17	3	1	4
Empyema	1	3	1	...	...	...
Peritonitis .....	...	...	1	...	...	...
Septicæmia	2	...	3	...	...	...
Pyelitis .....	...	1	...	...	...	...
Bronchiectasis .....	...	...	...	1	...	...
Coccidiosis .....	...	...	2	...	...	...
Cystitis .....	...	1	...	...	...	...
Bronchitis	8	...	...	1	...	1
Broncho-pneumonia	15	3	4	8	2	2
Congestion of lungs	5	...	3	3	1	1
Atelectasis .....	...	...	...	1	...	...
Cirrhosis of liver .....	...	1	...	...	...	...
Gastritis	1	...	...	...	...	...
Gastric ulceration	3	1	...	...	...	...
Gastro-enteritis	2	8	...	1	...	...
Enteritis	10	2	5	6	...	2
Intussusception	2	2	...	...	...	...
Intestinal obstruction .....	...	1	1	...	...	...
Nephritis	2	21	8	6	...	3
Cystitis .....	...	1	...	...	...	...
Atrophy of uterus .....	...	...	...	1	...	...
Retained placenta	1	...	...	...	...	...
Sarcoma .....	...	...	1	2	...	...
Carcinoma .....	...	1	...	1	...	...
Adenoma	1	...	...	...	...	...
Angioma .....	...	1	...	...	...	...

The following, Table IV., shows the number of Deaths from the numerically important Diseases for the last four years: the total number of animals of each class is placed above, so that a proper comparison can be made.

TABLE IV.

Mammals.

Year	1912.	1913.	1914.	1915.
Total number of mammals	1391	1272	1261	1013
Tuberculosis	14	31	12	6
Mycosis	12	8	6	10
Pneumonia	45	34	53	48
Bronchitis	12	6	11	10
Broncho-pneumonia	30	25	24	34
Congestion of lungs	14	14	14	13
Gastro-enteritis	11	7	16	11
Enteritis	38	33	33	25
Nephritis	89	90	66	40
<i>Birds.</i>				
Total number of birds	3526	3518	3610	3240
Tuberculosis	79	104	113	60
Mycosis	72	75	88	32
Pneumonia	98	89	118	70
Congestion of lungs	108	98	133	130
Enteritis	154	148	169	150
Nephritis	104	135	129	81
<i>Reptiles.</i>				
Total number of reptiles	1166	1169	1045	608
Tuberculosis	11	6	4	2
Mycosis	2	1	10	6
Pneumonia	124	138	69	34
Congestion of lungs	22	13	19	11
Enteritis	25	15	17	8

Notes on the foregoing Tables.

1. The total incidence of microbic and parasitic diseases in the Gardens for 1915 is 7·8 per cent. for mammals, 5·3 per cent. for birds, and 7·8 per cent. for reptiles. Practically this percentage is caused by the deaths of animals which had not been six months in the Gardens; if these be excluded, the percentage is under 1 per cent. for mammals and birds, and just over 1 per cent. for reptiles.

2. The deaths from tuberculosis have never been so few since accurate records have been kept as during this year. The percentage of animals dying from tubercle is ·5 for mammals, 1·8 for birds, and ·3 for reptiles. Three ungulates died from tubercle of human type, probably caused by spitting, which is one of the vices of visitors to the Gardens. A Cercopithecus

and a Baboon were both pet animals, but neither of them was allowed out of quarantine, which is the best way of keeping fresh infections out of the Gardens. The birds show a remarkable reduction of deaths from tubercle of nearly 50 per cent.; and, if the overcrowding of many of the bird-houses could be done away with, there does not seem any reason why there should not be a still further improvement. The greater number of the cases have been amongst the Gallinaceous birds, but this year a Flamingo succumbed to tubercle, for the first time since records have been kept. In only 19 of the birds were the lesions generalized, which is a much smaller percentage than usual, and indicates a less severe type of the disease. The 2 cases in the Reptile-houses make the smallest number since records were kept: there seems no reason why it should not be completely driven out. One of these cases was in a Crocodile, in which it was general; this is the first recorded case in this particular animal.

3. All the mould diseases are grouped under Mycosis. 6 of the mammals were Kangaroos and the disease was of the ordinary type; it occurred in a Deer and a Squirrel, for the first time, forming tumours in both—the moulds in each of these two cases were of a species new to the Gardens. There is a very great reduction in the number of cases occurring in birds, of considerably over 50 per cent. A Duck 14 days old was filled with growth of the organism, and, in a Pheasant, mycetomata (mycotic tumours) occurred in the lungs, which is very unusual in birds. Amongst the reptiles a Ceratophrys and an Anaconda died from mycetomata, and a Ceratodus, which had been many years in the Gardens, died from a mould disease of the skin, similar to that from which several of the larger toads and frogs have died.

4. There is a more than relative decrease in the number of cases of pneumonia, especially among the birds and reptiles. In the mammals it seems to be particularly associated with pyorrhœa and rickets. In two of the reptiles it was due to worm eggs and embryos, in the rest it was pneumococcal.

5. The septicæmias were due to dirty wounds in 3 cases, to pneumococci in 2 cases, and to an abscess in the antrum in 1 case.

6. Due to worm-cysts in a Squirrel, and in both of the birds due to injury, from, in the one case a nail, and in the other a thorn.

7. This occurred in a Deer, associated with putrid bronchitis, and was of the sacculated variety. It is the only case I have seen in an animal.

8. This was an acute hæmorrhagic cystitis in a Wolf, due to infection with *Bacillus coli*.

9. In a Cobra in which over 60 per cent. of the erythrocytes were infected.

10. Due to a rare parasite whose position is still uncertain, and found here in a reptile for the first time.

11. There has been relatively a slight general increase in these diseases of the respiratory organs. They are, of course, largely dependent upon weather.

12. There has been a slight decrease in the inflammatory affections of the alimentary tract. In 3 of the mammals and 50 of the birds it was hæmorrhagic, and in 1 of the reptiles it was caused by worms. The remainder of the cases were apparently due to the quantity or quality of the food not being suitable to the animal.

13. There has been relatively a considerable decrease in the number of cases of nephritis in the mammals and birds. 24 of the cases in mammals and 7 of those in birds were acute. The remainder were chronic cases, of varying degrees, a number of which were associated with other old-age changes. About 100 of the deaths have been due to old age, or to the artificial old age induced by captivity.

14. In a Kiang which died after delivery; the wall of the uterus measured only one-sixteenth of an inch in thickness.

15. One of these cases was in a Wolf whose son died of the same disease, in the same position, in July 1914.

16. Two of these cases were in Deer, one in the nose and the other in the liver and intestine; the third was a lymphosarcoma of the mediastinal glands in a Hamster.

17. Under the term malaria are grouped 1 case due to *Plasmodium kochi*, 7 cases due to *Hæmoproteus danilewskyi*, and 1 due to *Plasmodium præcox*: see also section on blood-parasites below.

18, 19, 21. See sections on blood-parasites below.

20. The blood of 3 Viperine Snakes contained a number of large amœbæ, probably from the intestine; they were also found in numbers in the liver of a Mocassin Snake (comparable with the flagellated organisms found in the blood of reptiles and described in my Reports of 1912 and 1913, and in a paper on Blood-parasites found in the Gardens during the years 1908-1911: *vide* P. Z. S. 1912, pp. 235, 406; 1913, p. 141; and 1914, p. 181).

22. Of the aorta in a Seal and a Coati.

23. The large number of cases of fatty degeneration and infiltration of the liver is probably due to too rich food and insufficient exercise. The greater number of the birds are the small, highly coloured birds from the Small Bird-house, whose food-capacity is enormous.

24. By far the greater number of cases of gastric ulceration occur in the Primates, generally in connection with diseases of the kidneys or lungs.

25. In an Ibex with very considerable faecal accumulation and symptoms of autointoxication.

26. Both kidneys of a Wallaby were filled with small stones: none in the bladder.

27. This was a small sarcomatous growth in the kidney of a Coypu Rat, probably arising from an adrenal inclusion.

BLOOD-PARASITES.

During the year the blood of every animal that died has been examined, with the result that parasites have been found in 46 cases, in 24 species for the first time.

They have been distributed as follows:—

Filariae. In 2 mammals; in 1 species for the first time.

In 6 birds; in 4 species for the first time.

In 1 reptile for the first time.

Trypanosomes. In 2 reptiles.

Malaria.	{	<i>Plasmodium kochi</i> . In 1 mammal for the first time.
		<i>Hæmoproteus danilewskyi</i> . In 7 birds; in 3 species for the first time.
		<i>Plasmodium præcox</i> . In 1 bird for the first time.

Leucocytozoa. In 3 birds; in all for the first time.

Toxoplasma. In 1 reptile for the first time.

Hæmogregarines. In 17 reptiles; in 7 species for the first time.

Intestinal organisms. In 5 reptiles; in 2 species for the first time.

The following list gives particulars of the blood-parasites in detail:—

Embryo Filariae found in the blood of Mammals.

	HABITAT.	TYPE.
Lion Marmoset (<i>Leontocebus rosalia</i>) ...	Brazil.	Very long.

Found in the following for the first time:

Woolly Monkey (<i>Lagothrix infumata</i>)...	S. America.	Long.
--	-------------	-------

Embryo Filariae found in the blood of Birds.

Chilian Starling (<i>Curæus aterrimus</i>) ...	Chili.
--	--------

Found in the following for the first time:

White-eyebrowed Wood-Swallow (<i>Artamus superciliosus</i>).	N.S. Wales.	Long, thick.
3 Red Birds of Paradise (<i>Paradisea rubra</i>).	Waigiou Island.	Short, stout; 2 of the birds contained also filariæ of long thin type.
Military Starling (<i>Trupialis militaris</i>) .	Chili.	Long, thin.

Embryo Filariae found in the blood of a Reptile: for the first time.

Wolf-Snake (<i>Coluber lætus</i>)	N. America.	Long, thin.
---	-------------	-------------

Trypanosomes found in the blood of Reptiles.

2 Edible Frogs (<i>Rana esculenta</i>)	Europe.	<i>T. rotatorium</i> type.
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Plasmodium kochi found in the blood of the following Mammal
for the first time.

	HABITAT.
Mangabey (<i>Cercocebus æthiopicus</i>)	S. Nigeria.

Hæmoproteus danilewskyi found in the blood of Birds.

Indian Dial Bird (<i>Copsychus saularis</i>)	India.
Black-throated Lorikeet (<i>Trichoglossus nigrogenis</i>)	Tasmania.
2 Brown-necked Parrots (<i>Pæocephalus fuscicollis</i>)	Gambia.

Found in the following for the first time:

Yellow-fronted Barbet (<i>Cyanops flavifrons</i>)	Ceylon.
Larger Hill-Mynah (<i>Gracula intermedia</i>)	N. India.
Red Bird of Paradise (<i>Paradisæa rubra</i>)	Waigiou Island.

Plasmodium præcox found in the blood of the following Bird
for the first time.

American Robin (<i>Turdus migratorius</i>)	N. America.
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Leucocytozoa found in the blood of the following Birds
for the first time.

White-eyebrowed Wood-Swallow (<i>Artamus superciliosus</i>)...	N.S. Wales.
Nonpareil Finch (<i>Cyanospiza ciris</i>)	N. America.
Alario Finch (<i>Alario alario</i>)	S. Africa.

Toxoplasma found in the blood of the following Reptile
for the first time.

Say's Snake (<i>Coluber melanoleucus</i>)	Mexico.
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Hæmogregarines found in the blood of Reptiles.

Indian Python (<i>Python molurus</i>)	India.
2 Indian Cobras (<i>Naia tripudians</i>)	India.
Hog-nosed Snake (<i>Heterodon platyrhinus</i>)	N. America.
Blood-stained Terrapin (<i>Cinosternum cruentatum</i>)	N. America.
Æsculapian Snake (<i>Coluber longissimus</i>)	Europe.
Common Boa (<i>Boa constrictor</i>)	S. America.
Banded-tailed Tree-Snake (<i>Leptophis liocercus</i>)	S. America.
Anaconda (<i>Eunectes marinus</i>)	S. America.
Cooke's Tree-Boa (<i>Corallus cookii</i>)	Trinidad.

Found in the following for the first time:

	HABITAT.	TYPE.
Wolf Snake (<i>Coluber lætus</i>)	N. America.	Cells enlarged and de-hæmoglobinised.
Pennsylvanian Mud-Terrapin (<i>Cinosternum pennsylvanicum</i>).	N. America.	Stout.
Black-collared Cobra (<i>Naia nigricollis</i>).	W. Africa.	Long.
2 West African Sand-Snakes (<i>Psammophis elegans</i>).	W. Africa.	Cells enlarged and de-hæmoglobinised.
West African Trionyx (<i>Trionyx triunguis</i>)	W. Africa.	Stout.
Rufescent Snake (<i>Leptodira hotambæia</i>).	W. Africa.	Very small, like <i>Lankestrella</i> .
Shielded Eryx (<i>Eryx thebaicus</i>)	Gold Coast.	Long, irregular: cells de-hæmoglobinised.

Intestinal Organisms found in the blood of Reptiles.

	HABITAT.	TYPE.
Carolina Box-Tortoise (<i>Cistudo carolina</i>).	N. America.	Hexamitus.

Found in the following for the first time :

3 Viperine Snakes (<i>Tropidonotus viperinus</i>).	Europe.	Amœbæ.
Mocassin Snake (<i>Tropidonotus fasciatus</i>)	N. America.	Amœbæ.

*Addendum to Report on the Deaths for 1914, published
in Proc. Zool. Soc., March 1915.*

Owing to the wrong figures having been sent to me from the Office, the figures in paragraphs 1 and 2 of the 1914 Report, p. 123, and in paragraphs 1 and 2 of the Notes, p. 126, are incorrect: these paragraphs should read as follows:—

Paragraphs 1 and 2, p. 123.

On January 1st, 1914, there were 788 mammals, 2436 birds, and 575 reptiles in the Zoological Gardens; and during the year 373 mammals, 1174 birds, and 470 reptiles were admitted, making a total for the year of 1261 mammals, 3610 birds, and 1045 reptiles.

During 1914, 309 mammals, 867 birds, and 301 reptiles have died: that is, a percentage of 24·6 for mammals, 24 for birds, and 28·8 for reptiles. Of these 719 animals, 141 were mammals, 375 were birds, and 203 were reptiles; and if these be deducted from their respective totals, the death-rate percentage will come out as 13·3 for mammals, 13·6 for birds, and 9·3 for reptiles.

Paragraphs 1 and 2 of *Notes on the foregoing Tables*, p. 126, will read as follows:—

1. The total incidence of infectious diseases in the Gardens is about 7·5 per cent. for mammals, 9 per cent. for birds, and 8·1 per cent. for reptiles.

2. The following are the percentages of deaths from tubercle during the year: mammals ·9 per cent., birds 3·1 per cent., and reptiles ·38 per cent. on the total numbers for the year, etc., etc.

4. A Frog with symmetrically Abnormal Hind Feet. By R. W. HAROLD ROW, B.Sc., F.L.S., F.Z.S., Assistant Lecturer and Demonstrator in Zoology, University of London, King's College.

[Received and Read November 23, 1915.]

(Text-figure 1.)

Among the specimens used for the teaching of elementary zoology at this College, there was recently found an example of the Common Frog (*Rana temporaria*) in which both the hind feet showed a curious and interesting variation. A photograph of the external appearance of the two hind feet is given (text-fig. 1, A), which clearly shows that on neither foot do five functional digits exist; though in both cases a small calcar, or pre-hallux, as it is often called, is present in its normal position in addition to four well-developed and normal toes.

The fact that certain of the toes always present definite characteristics which enable them to be indubitably identified, quite apart from their actual numerical position in the series, renders it quite easy to determine the identity of the digits still present in the four-toed specimen. Of these characteristics the most obvious distinguishes the fourth toe, which is not only longer than any of the others, but also always possesses four phalanges, which is one more than the number present in any other digit. In the specimen under discussion four phalanges can be distinguished on one toe on each hind foot, so that this toe is thus marked out as the fourth of the original series, and from this it can be immediately determined that the missing digit is in each case the first. This identification of the digits is shown on the photograph.

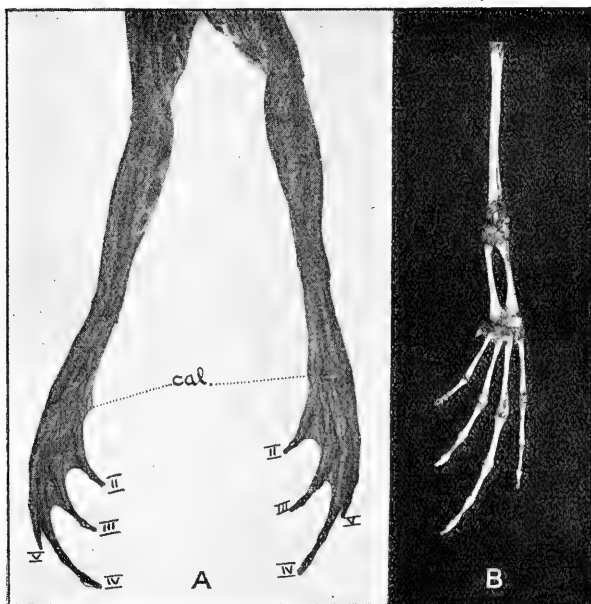
In view of the possibility, however unlikely, that symmetrical mutilation of both hind feet might have occurred, one foot, the left, has been completely dissected, and the dissection has shown that the abnormality cannot be due to injury, for the first digit is unrepresented by any tissue whatever.

During the dissection great care was exercised to determine whether the muscles of the hallux were represented, and no trace whatever of them was found, either in the form of small muscle-masses or of fragments of muscular tissue or tendons, such as would inevitably be left had the toe been bitten off or otherwise amputated. The musculature of digit II (and of all the other digits) was perfectly normal, and showed no signs of the inclusion of muscles really belonging to digit I. Specially important is the fact that from the *aponeurosis plantaris* only four *tendines superficiales* arise, the one normally associated with the first digit being totally absent. There is also no trace of any of the bones

of the hallux in the skeleton of the foot, nor any gap between the calcar and digit II from which the hallux might have been removed, and these facts taken together do away completely with any possibility that the abnormality is due to injury. A photograph (text-fig. 1, B) is given of the skeleton.

All the normal distal tarsal bones are present in the foot in their normal position, though, unfortunately, they are not distinguishable in the figure; the four digits present are also perfectly normal in their anatomy.

Text-figure 1.



A. Photograph of the external appearance of the two hind feet, natural size.

B. Photograph of the skeleton of the left hind foot, natural size.

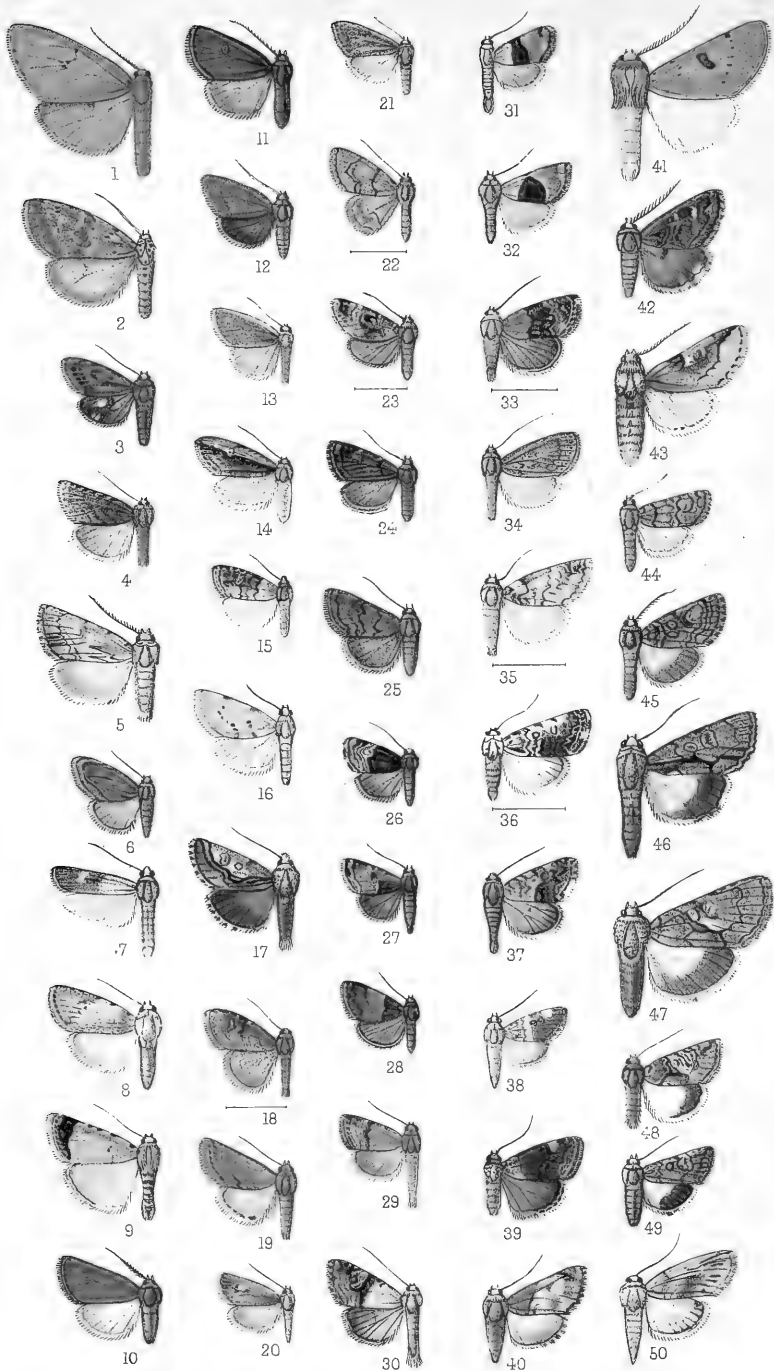
It was decided not to dissect the right foot, but as careful an examination as possible was made from the outside, and revealed no indication of the hallux in that foot either.

One question I cannot definitely settle. It is just possible that the structure identified by me as the calcar is really the remnant of the hallux, in which case the calcar is entirely absent in both feet. I do not think that this can be the case, however, for the following reasons. The position of this structure in the abnormal specimen precisely corresponds to that of the calcar in the normal frog, both as regards the foot generally and in its

relation to the distal tarsal bones: its size is just that of the normal calcar; and, in addition, in dissecting the foot I found that its muscles corresponded exactly with the account given in Gaupp's Ecker-Wiedersheim's '*Anatomie des Frosches*' for the musculature of the calcar.

One of the most interesting points in connexion with this abnormality is the fact that in the manus of the frog there are always only four digits, and the one usually accounted absent is again the first of the series, though Emery (*Anat. Anz. Bd. v. 1890*, pp. 283-288; and elsewhere) has claimed that the missing finger is really the fifth. But whether the absence of the first digit from the hind feet of the abnormal specimen can be regarded as additional evidence tending to disprove Emery's theory, or not, I cannot say. Another point of theoretical interest lies in the presence of the calcar despite the absence of the hallux, which seems to me to afford considerable support to the view that the former does not belong in any way to the digital series. Theoretical considerations based upon a single specimen are far too doubtful, however, to render it worth while attempting to discuss these questions.

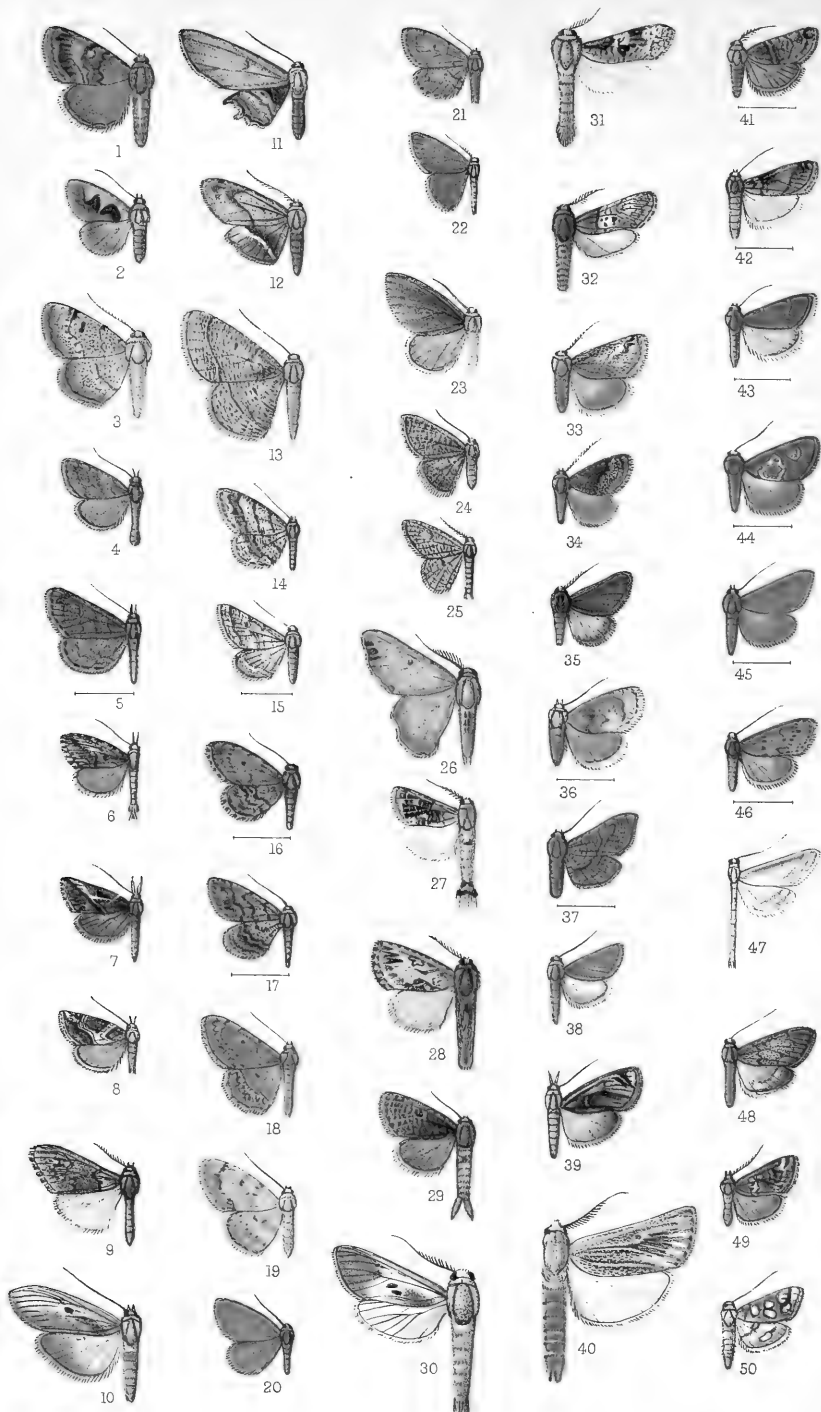
Among the great number of structural abnormalities which have been described for frogs of various species, a number of cases of polymely and polydactyly occur; but apparently this specimen is the first in which a variation of this kind has been recorded.



Horace Knight del. et lith.

West, Newman chr

SOMALILAND LEPIDOPTERA.



Horace Knight del. et lith.

West, Newman chr.

5. On a Collection of Moths made in Somaliland by Mr. W. Feather. By Professor E. B. POULTON, M.A., F.R.S., F.Z.S. With Descriptions of New Species, by Sir G. F. HAMPSON, Bart., L. B. PROUT, J. H. DURRANT, and Dr. KARL JORDAN.

[Received November 23, 1915 : Read February 8, 1916.]

(Plates I. & II.*)

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109 species and 2 subspecies are also described as new.

The moths described in the following pages were very carefully collected by Mr. Walter Feather, who preserved excellent data. Sir George Hampson has described the new species of all the groups except the Sphingidæ, by Dr. Karl Jordan, the Geometridæ, by Mr. L. B. Prout, and the Tineina, by Mr. J. H. Durrant. The order of the species is from the more specialised to the more generalised except in the Geometridæ, which Mr. Prout has arranged in the opposite sequence.

Types of the species described by Sir George Hampson and Mr. Durrant are in the collection of the British Museum, co-types, when the series permits, in the Hope Department, Oxford University Museum, and Mr. Feather's collection. Dr. Jordan's and Mr. Prout's types are in the Hope Collection, co-types, when the series permits, in the British Museum, Mr. Feather's collection, and that of the describer. This statement renders unnecessary any further reference to the disposition of types and co-types in the descriptive part of this memoir.

* For explanation of the Plates, see pp. 181-2.

The numbers prefixed to the names of species in the first part of the memoir are those of Hampson's 'Catalogue of Lepidoptera Phalænæ in the British Museum,' the position of new species being indicated by letters added to the numbers of the most closely allied species in the Catalogue. Thus species 2094*a* would immediately follow 2094 in the Arctianæ of the Catalogue.

The specimens were collected at the following localities, of which the descriptions have been kindly furnished by Mr. Feather :—

MANDERA.

Forty-seven miles south-west of Berbera, alt. 3000 ft.

Rocks, grey and red granite.

Open and bush country, bush being mainly made up of thorny trees, nearly all flat-topped Acacias or Mimosa. Big areas covered with fibre-plants (*Sanseveria ehrenbergi*).

GAN LIBBAH.

(The "Lion's Paw.")

In the Golis Mts., seven miles east of Mandera, alt. 5800 ft.

Rock, limestone (Jurassic).

Good patches of big trees, mainly Juniper; also Euphorbias.

Good grass land with scarcely any thorn-bush.

BUGGAN.

Ten miles south of Mandera, alt. 3500 ft.

Rock, granite.

Thorn country, fairly open: few big wild Fig-trees.

HARGAISA.

One hundred and twenty miles south-west of Berbera, alt. 4000 ft.

Bush and trees same as Mandera, but a little denser. Bigger areas of *Sanseveria ehrenbergi*.

BERBERA.

All the moths I captured at Berbera were taken in the Bungalow at light. This was close to the sea; the maritime plain is very thinly covered with a low-growing thorn-bush.

Rock, coralline limestone.

DURBAR.

Nine miles south of Berbera, alt. 400 ft.

Rock, limestone.

Open land, few Palms with some rough grass.

Durbar is really the waterworks for Berbera, and at one time there was a poor sort of Government garden there.

With few exceptions the specimens were captured at Mandera, and this place is to be understood when no locality is mentioned in the text. Mandera is, however, always quoted for those comparatively few species which were also taken elsewhere. The specimens from Hargaisa dated Oct. 1908 were taken during a period of about two or three weeks by Captain Jorkinson.

Mr. Feather writes concerning the method of capture:—"I may say that all the moths were collected at light. I only remember taking one species—I think a Geometer—otherwise, and that I got in a porcupine-burrow along with a Skipper. I sugared many times, but the only insects that came were ants, and they completely covered the sugar."

Mr. L. B. Prout, in the introduction to the Geometridæ (p. 142), draws attention to the remarkable preponderance of females; and the same unusual condition is to be found again and again throughout the rest of the collection. Observations made Sept. 12-15, 1915, in Bombay Harbour, on the return from the visit of the British Association to Australia, have led me to believe that nocturnal flights of female Lepidoptera tend to occur during wet weather. The Bombay species included the females of certain butterflies which flew at night and came to light with the moths. The fact seems to be very interesting and well worthy of a separate communication dealing with these Somaliland moths and my own experience in Bombay. In order to test the relationship of female preponderance to wet weather, I have asked Mr. Feather to supply a record of the rainfall and temperature at Mandera. He kindly replied as follows:—

"I am enclosing the record of rainfall for Mandera, and have used much the same words as I wrote in my diary. My impressions of the rainfall were guided by what I had been used to in England, as this was my first visit to Africa.

"I cannot give you the amount of rain, as we had no rain-gauge. I should say the annual rainfall at Mandera is about 10-12 inches. Wet nights are a great rarity, the rain oftenest coming in short heavy showers in the morning or afternoon.

"The river I mention is, of course, a dry river-bed, except just after rain. The longest time that I remember water running down the channel was for about 8 hours. The river-bed is about 120 yards wide, and in one part was a very small stream of permanent water, which appeared between some rocks and ran on the surface for 20-30 yards before disappearing in the sand."

RECORD of Rain at Mandera, Somaliland, from Nov. 14th, 1907, to June 23rd, 1909, and of Temperatures, taken in the shade, from March 14th, 1908, to June 30th, 1909.

Date.	Morning and afternoon temperature (Fahrenheit).				Rainfall.
Nov. 14, 1907.	.....	.....	.....	.....	Rain in morning.
— 15, —	.....	.....	.....	.....	Rain in afternoon.
Jan. 22, 1908.	.....	.....	.....	.....	Fine drizzle all day.
Mar. 14, —	6.30 A.M. 65 deg.	1.30 P.M. 102 deg.			
— 15, —	— — 68 —	2.0 — 103 —			
— 16, —	6.0 — 63 —	— — 105 —			
— 17, —	6.30 — 66 —	1.0 — 104 —			
— 18, —	— — 65 —	1.30 — 104 —			
— 19, —	6.0 — 68 —	— — 105 —			
— 20, —	6.30 — 68 —	12.30 — 100 —			
— 21, —	— — 70 —	2.0 — 106 —			
— 22, —	— — 63 —	2.30 — 108 —			
— 23, —	— — 70 —				
— 24, —	6.0 — 68 —	2.30 — 98 —			
April 1, —	— — 70 —				
— 2, —	— — 67 —	12.30 — 93 —			
— 3, —	— — 68 —				
— 4, —	— — 69 —				
— 7, —	— — 70 —	1.0 — 90 —			
— 8, —	— — 75 —				
— 9, —	— — 68 —				
— 10, —	— — 68 —	1.0 — 78 —			Dull day: a few drops of rain.
— 11, —	— — 68 —	— — 85 —			
— 12, —	— — 64 —	— — 84 —			
— 13, —	— — 59 —				
— 14, —	— — 64 —	2.0 — 81 —			
— 15, —	— — 59 —	1.30 — 85 —			
— 16, —	— — 61 —	1.0 — 88 —			
— 17, —	— — — —	2.0 — 96 —			
— 18, —	— — 66 —	— — 96 —			
— 19, —	— — 77 —	— — 97 —			
— 20, —	— — 80 —	— — 86 —			Slight shower in morning.
— 21, —	5.30 — 75 —	1.0 — 93 —			Heavy shower.
— 22, —	— — 71 —	1.30 — 86 —			
— 23, —	— — 69 —	2.0 — 79 —			Heavy rain for 1½ hrs.
— 24, —	6.0 — 70 —	1.30 — 81 —			Rain for 2 hrs.
— 25, —	— — 73 —	2.0 — 96 —			
— 26, —	— — 73 —	— — 93 —			
— 27, —	— — 73 —	1.0 — 95 —			
— 28, —	— — 77 —	2.0 — 95 —			
— 29, —	5.30 — 77 —	— — 96 —			
— 30, —	6.0 — 77 —	— — 87 —			
May 1, —	— — 75 —	— — 84 —			
— 2, —	— — 71 —	— — 90 —			
— 3, —	— — — —	— — 93 —			
— 4, —	5.30 — 78 —	12.30 — 93 —			Slight shower.
— 5, —	6.0 — 78 —	2.0 — 95 —			Slight shower.
— 6, —	— — 78 —	— — 93 —			A short shower a little before sunset. During the shower hailstones $\frac{1}{4}$ in. to $\frac{3}{4}$ in. in diameter fell.
— 7, —	— — 74 —	— — 84 —			
— 8, —	— — 72 —	— — 93 —			
— 9, —	— — 70 —				
— 10, —	— — 75 —	— — 84 —			

Date.		Morning and afternoon temperature (Fahrenheit).		Rainfall.
May	12, 1908.	5.30 A.M. 73 deg.	1.30 P.M. 94 deg.	Short shower. Heavy shower in afternoon for 1½ hrs.; hailstones.
—	13, —	— — 74 —	— — 94 —	
—	14, —	6.0 — 75 —	2.0 — 94 —	
—	15, —	— — 75 —	— — 93 —	Slight shower. Fairly heavy shower. Tempe- rature fell considerably.
—	16, —	— — 76 —	— — 84 —	
—	17, —	— — 70 —	1.30 — 69 —	
—	18, —	— — 66 —	— — 84 —	
—	19, —	— — 65 —	— — 84 —	
—	20, —	— — 75 —	— — 91 —	
—	21, —	— — 71 —	— — 91 —	
—	22, —	— — 68 —	— — 91 —	
—	23, —	— — 68 —	— — 94 —	
—	24, —	— — 75 —	— — 94 —	
—	25, —	— — 74 —	1.0 — 94 —	
—	26, —	— — 73 —	— — 94 —	
—	27, —	— — 75 —	1.30 — 93 —	
—	28, —	— — 65 —	— — 91 —	
—	29, —	— — 77 —	— — 91 —	
—	30, —	— — 79 —	— — 93 —	
—	31, —	— — 75 —	2.0 — 95 —	
June	1, —	— — 76 —	— — 95 —	
—	2, —	— — 76 —	1.30 — 94 —	
—	3, —	— — 78 —	— — 94 —	
—	4, —	— — 77 —	— — 92 —	
—	5, —	— — 75 —	— — 92 —	
—	6, —	— — 75 —	2.0 — 88 —	A good heavy shower, starting at 3 P.M. and lasting till 5 P.M.; water coming down the river in fair quantity.
—	7, —	— — 74 —	— — 91 —	
—	8, —	— — 76 —	— — 93 —	
—	9, —	— — 75 —	— — 96 —	
—	10, —	— — 77 —	— — 95 —	
—	11, —	— — 75 —	— — 93 —	
—	12, —	— — 74 —	— — 92 —	
—	13, —	— — 73 —	— — 93 —	
—	15, —	— — 73 —	— — 95 —	
—	16, —	— — 75 —	— — 94 —	
—	17, —	— — 78 —	— — 94 —	
—	18, —	— — 78 —	— — 94 —	
—	19*, —	— — 78 —	— — 94 —	
—	29, —	— — 75 —	— — 102 —	
—	30, —	— — 73 —	— — 101 —	Water came down river last night. Evidently heavy rain in the hills, though none at Mandera.
July	1, —	— — 79 —	— — 102 —	
—	2, —	— — 75 —	— — 103 —	
—	3, —	— — 78 —	— — 98 —	
—	4, —	— — 78 —	— — 101 —	
—	5, —	— — — —	— — 100 —	
—	6, —	— — 75 —	— — 100 —	
—	7, —	— — 77 —	— — 100 —	
—	8, —	— — 77 —	— — 103 —	
—	—	— — — —	— — — —	Heavy shower; water coming down river.

* Here I have a note that I took the thermometer from the inside of the messhouse and hung it on the veranda (well in the shade). The temperature then immediately rose to 103 deg.

Date.	Morning and afternoon temperature (Fahrenheit).		Rainfall.
July 9, 1908.	6.0 A.M. 78 deg.	1.30 P.M. 101 deg.	
— 10, —	— — 77 —	2.0 — 101 —	
— 11, —	— — 76 —	— — 101 —	
— 12, —	— — 76 —	— — 101 —	
— 13, —	— — 76 —	— — 102 —	
— 14, —	— — 77 —	— — 102 —	
— 15, —	— — 77 —	— — 102 —	
— 16, —	— — 78 —	— — 102 —	
— 17, —	— — 77 —	— — 100 —	
— 18, —	— — 75 —	— — 102 —	
— 19, —	— — 77 —		
— 20, —	— — 77 —	— — 99 —	
— 21, —	— — 75 —	— — 98 —	
— 22, —	— — 75 —	— — 99 —	
— 23, —	— — 78 —	3.0 — 98 —	
— 24, —	— — 78 —	2.0 — 98 —	
— 25, —	— — 78 —	— — 98 —	
— 26, —		— — 100 —	
— 27, —	— — 73 —	— — 95 —	
— 28, —	— — 76 —	— — 98 —	
— 29, —	— — 70 —	— — 95 —	
— 30, —	— — 70 —	— — 93 —	Had two rather dull days. A good shower this evening.
— 31, —	— — 75 —	— — 97 —	
Aug. 1, —	— — 75 —	— — 92 —	
— 2, —	— — 75 —	— — 87 —	
— 3, —	— — 73 —	— — 92 —	
— 4, —	— — 77 —	— — 97 —	
— 5, —	— — 78 —	— — 100 —	
— 6, —	— — 78 —	2.30 — 101 —	
— 7, —	— — 75 —	— — 90 —	
— 8, —	— — 70 —	2.0 — 92 —	
— 9, —	— — 73 —	2.30 — 93 —	
— 10, —	— — 76 —	2.0 — 97 —	
— 11, —	— — 71 —	— — 92 —	
— 12, —	— — 78 —	2.30 — 100 —	
— 13, —	— — 76 —	2.0 — 98 —	
— 14, —	— — 77 —	2.30 — 99 —	
— 15, —	— — 76 —	— — 101 —	
— 16, —		2.0 — 101 —	
— 17, —	— — 79 —	2.0 — 101 —	
— 18, —	— — 80 —	— — 103 —	
— 19, —	— — 79 —	— — 101 —	
— 20, —	6.30 — 79 —	— — 103 —	
— 21, —	6.0 — 80 —	— — 101 —	
— 22, —	— — 79 —	— — 101 —	
— 23, —			A shower this evening.
— 24, —	— — 75 —	2.30 — 98 —	
— 25, —	— — 77 —	— — 100 —	
— 26, —	— — 77 —	— — 103 —	
— 27, —	— — 78 —	2.0 — 100 —	
— 28, —	6.30 — 77 —	2.30 — 100 —	
— 29, —	— — 75 —	2.0 — 98 —	
— 31, —	Berbera.—Temp. in Bungalow, 116 deg.]		
Sept. 3, —	6.0 A.M. 76 deg.	2.0 P.M. 98 deg.	
— 4, —	6.30 — 77 —	2.30 — 98 —	
— 5, —	6.0 — 75 —	— — 99 —	
— 6, —	— — 73 —	— — 95 —	
— 7, —	— — 74 —	— — 94 —	
— 8, —	6.30 — 77 —	— — 97 —	
— 9, —	6.0 — 77 —	2.0 — 99 —	
— 10, —	— — 75 —	2.30 — 102 —	

Date.	Morning and afternoon temperature (Fahrenheit).		Rainfall.
Sept. 11, 1908.	6.30 A.M. 75 deg.	2.30 P.M. 102 deg.	
— 12, —	— — —	3.0 — 104 —	
— 13, —	7.0 — 79 —	— — 101 —	
— 14, —	6.0 — 75 —	3.30 — 95 —	
— 15, —	7.0 — 77 —	2.30 — 101 —	
— 16, —	6.30 — 78 —	— — 96 —	
— 17, —	— — 75 —	1.30 — 98 —	
— 18, —	— — 76 —	2.30 — 96 —	
— 19, —	6.0 — 77 —	2.0 — 87 —	
— 20, —	— — 72 —	— — 95 —	Rain around, but only a few drops here; Mandera often seems to miss the rain.
— 21, —	— — 75 —	— — 95 —	
— 22, —	— — 76 —	2.30 — 99 —	
— 23, —	— — 76 —	— — 99 —	
— 24, —	— — 74 —	2.0 — 96 —	A few drops of rain at noon.
— 25, —	— — 75 —	— — 95 —	A good heavy shower, lasting about 20 mins.
— 26, —	5.30 — 73 —	2.30 — 94 —	
— 27, —	6.0 — 73 —	1.30 — 94 —	
— 28, —	— — 74 —	— — 89 —	
— 29, —	— — 74 —	— — 95 —	
— 30, —	— — 75 —	— — 90 —	A very slight shower at night. A good shower lasting 15 mins. this day. The last few days have been cloudy in early morning and late afternoon.
Oct. 1, —	— — 74 —	— — 90 —	
— 2, —	— — 72 —	2.0 — 92 —	
— 3, —	— — 75 —	1.30 — 92 —	
— 4, —	— — 75 —	2.0 — 92 —	
— 5, —	— — 73 —	1.30 — 90 —	
— 6, —	— — 72 —	— — 90 —	Heavy shower for 10 mins.
— 7, —	— — 69 —	— — 88 —	Slight shower in afternoon.
— 8, —	— — 68 —	2.0 — 88 —	
— 9, —	— — 72 —	— — 90 —	
— 10, —	6.30 — 66 —	— — 89 —	
— 11, —	6.0 — 67 —	— — 92 —	
— 12, —	6.15 — 65 —	1.30 — 94 —	
— 13, —	6.0 — 75 —	2.0 — 80 —	A few drops of rain.
— 14, —	— — 65 —	1.30 — 86 —	Water down river in quantity, but no rain at Mandera.
— 15, —	— — 63 —	— — 87 —	
— 16, —	— — 67 —	2.0 — 87 —	
— 17, —	— — 64 —	1.30 — 87 —	
— 18, —	— — 65 —	— — 87 —	
— 19, —	— — 63 —	2.0 — 85 —	
— 20, —	— — 65 —	— — 83 —	
— 21, —	6.30 — 59 —	— — 85 —	
— 22, —	— — 61 —	— — 83 —	
— 23, —	6.0 — 65 —	— — 83 —	
— 24, —	— — 59 —	— — 83 —	
— 25, —	— — 61 —	2.0 — 80 —	
— 26, —	— — 60 —	— — 78 —	A few drops of rain at night.
— 27, —	— — 66 —	— — 77 —	Slight shower in morning.
— 28, —	— — 68 —	— — 83 —	
— 29, —	— — 58 —	— — 87 —	
— 30, —	— — 61 —	— — 88 —	
— 31, —	— — 60 —	— — 89 —	
Nov. 1, —	— — 61 —	— — 88 —	
— 2, —	— — 68 —	— — 80 —	A good shower.
— 3, —	— — 66 —	1.30 — 76 —	
— 4, —	— — 68 —	— — 82 —	
[— 9, —	Gan Libbah.—Few drops of rain.]		

Date.	Morning and afternoon temperature (Fahrenheit).				Rainfall.
[Nov. 10, 1908.	Gan Libbah.—Rain for 2 hrs.]				
— 12, —	6.0	A.M.	62	deg.	
— 13, —	—	—	61	—	2.0 P.M. 82 deg.
— 14, —	—	—	—	—	2.30 — 78 —
— 15, —	—	—	59	—	2.0 — 80 —
— 16, —	—	—	59	—	— 80 —
— 17, —	—	—	56	—	1.30 — 82 —
— 18, —	—	—	60	—	— 80 —
— 19, —	—	—	59	—	— 80 —
— 20, —	—	—	59	—	— 80 —
— 21, —	—	—	57	—	
— 22, —	—	—	53	—	
— 23, —	—	—	56	—	
— 24, —	—	—	53	—	1.30 — 85 —
— 25, —	—	—	50	—	3.30 — 82 —
— 26, —	—	—	55	—	2.30 — 78 —
— 27, —	—	—	48	—	2.30 — 74 —
— 28, —	—	—	55	—	
— 29, —	Berbera.				A few drops.]
Dec. 21, —	—	—	51	—	2.0 — 72 —
— 25, —	—	—	55	—	3.0 — 70 —
— 26, —	—	—	53	—	— 75 —
— 27, —	6.30	—	48	—	2.0 — 75 —
— 28, —	6.0	—	51	—	1.0 — 75 —
— 29, —	—	—	57	—	1.30 — 73 —
— 30, —	—	—	53	—	— 73 —
— 31, —	—	—	54	—	1.0 — 73 —
Jan. 1, 1909.	—	—	52	—	— 72 —
— 2, —	—	—	51	—	— 73 —
— 3, —	—	—	49	—	— 72 —
— 4, —	—	—	53	—	— 70 —
— 5, —	—	—	51	—	
— 11, —	—	—	60	—	— 72 —
— 12, —	—	—	55	—	— 73 —
— 13, —	—	—	50	—	2.0 — 75 —
— 14, —	—	—	53	—	— 81 —
— 15, —	—	—	55	—	1.30 — 80 —
— 16, —	—	—	60	—	— 81 —
— 17, —	—	—	58	—	2.0 — 83 —
— 18, —	—	—	60	—	1.30 — 80 —
— 19, —	—	—	60	—	— 80 —
— 20, —	—	—	61	—	— 81 —
— 21, —	—	—	63	—	2.0 — 86 —
— 22, —	—	—	60	—	1.30 — 78 —
— 23, —	—	—	63	—	1.30 — 73 —
— 24, —	—	—	60	—	2.0 — 75 —
— 25, —	—	—	60	—	1.30 — 78 —
— 26, —	—	—	60	—	— 77 —
— 27, —	—	—	58	—	— 76 —
— 28, —	—	—	53	—	2.0 — 70 —
— 29, —	—	—	50	—	1.0 — 70 —
— 30, —	—	—	50	—	1.30 — 75 —
— 31, —	—	—	51	—	— 77 —
Feb. 1, —	—	—	52	—	— 80 —
— 2, —	—	—	55	—	— 80 —
— 3, —	—	—	55	—	— 75 —
— 4, —	—	—	60	—	— 75 —
— 5, —	—	—	60	—	— 77 —
— 6, —	—	—	61	—	— 76 —
— 7, —	—	—	60	—	2.0 — 74 —
— 8, —	—	—	57	—	— 75 —

Fairly heavy dews for the last
[4 weeks.

A few drops.

Date.		Morning and afternoon temperature (Fahrenheit).		Rainfall.
Feb.	9, 1909.	6.0 A.M. 55 deg.	2.0 P.M. 73 deg.	
—	10, —	— — 56 —	— — 73 —	
—	11, —	— — 58 —	1.30 — 85 —	
—	12, —	— — 57 —	— — 75 —	
—	13, —	— — 58 —	— — 79 —	
—	14, —	— — 59 —	2.0 — 79 —	
—	15, —	— — 58 —	1.30 — 79 —	
—	16, —	— — 55 —	1.0 — 81 —	
—	17, —	— — 54 —	— — 85 —	
—	18, —	— — 59 —	1.30 — 81 —	
—	19, —	— — 60 —	— — 84 —	
—	20, —	— — 60 —	— — 81 —	
—	21, —	— — 61 —	2.0 — 78 —	
—	22, —	— — 61 —	— — 80 —	
—	23, —	— — 56 —	1.30 — 83 —	
—	24, —	— — 56 —	— — — —	
—	25, —	— — 57 —	— — 83 —	
—	26, —	— — 60 —	— — 81 —	
—	27, —	— — 57 —	— — 83 —	
—	28, —	— — 57 —	— — 81 —	
Mar.	1, —	— — 57 —	1.0 — 85 —	
—	2, —	— — 60 —	1.30 — 81 —	
—	3, —	— — 56 —	1.0 — 75 —	
—	4, —	— — 58 —	— — 79 —	
—	5, —	— — 59 —	1.30 — 81 —	
—	6, —	— — 59 —	— — 80 —	
—	7, —	— — 61 —	1.0 — 76 —	
—	8, —	— — 61 —	— — — —	
—	9, —	— — 58 —	1.30 — 80 —	
—	10, —	— — 60 —	— — 78 —	
—	11, —	— — 59 —	— — 79 —	
—	12, —	— — 58 —	— — 80 —	
—	13, —	— — 58 —	— — 82 —	
—	14, —	— — 57 —	— — 81 —	
—	15, —	— — 58 —	— — 77 —	
—	16, —	— — 57 —	— — 85 —	
—	17, —	— — 53 —	2.0 — 87 —	
—	18, —	— — 55 —	— — 85 —	
—	19, —	— — 57 —	1.30 — 82 —	
—	20, —	— — 58 —	— — 78 —	
—	21, —	— — 58 —	1.0 — 87 —	
—	22, —	— — 62 —	— — 96 —	
—	23, —	— — 65 —	— — 99 —	
—	24, —	— — 63 —	1.30 — 88 —	
—	25, —	— — 63 —	1.0 — 90 —	
—	26, —	— — 63 —	— — 91 —	
—	27, —	— — 68 —	— — 75 —	Heavy rain.
—	28, —	— — 68 —	— — 80 —	
—	29, —	— — 68 —	— — 87 —	Good shower in afternoon.
—	30, —	— — 69 —	— — 90 —	
—	31, —	— — 69 —	— — 82 —	
April	1, —	— — 69 —	1.30 — 85 —	Few drops. Much rain in hills.
—	2, —	— — 71 —	— — 87 —	Steady rain for 2 hours.
—	3, —	— — 66 —	— — 82 —	No rain, but river came down in strength.
—	4, —	— — 70 —	— — 72 —	Good shower.
—	5, —	— — 71 —	— — 82 —	Good shower.
—	6, —	— — 70 —	— — 89 —	
—	7, —	— — 70 —	— — 95 —	
—	8, —	— — 71 —	— — 95 —	Rained in afternoon. Heavy storms all round.

Date.	Morning and afternoon temperature (Fahrenheit).				Rainfall.
April 9, 1909.	6.0 A.M.	70 deg.	1.30 P.M.	67 deg.	
— 10, —	— —	68 —	— —	82 —	
— 11, —	— —	65 —	— —	82 —	Shower in early morning.
— 12, —	— —	68 —	— —	83 —	
— 13, —	— —	72 —	— —	95 —	
— 14, —	— —	73 —	— —	97 —	Shower in afternoon.
— 15, —	— —	73 —	— —	87 —	
— 16, —	— —	71 —	— —	85 —	Few short showers in night.
— 17, —	— —	65 —	— —	82 —	Little water coming down river at daylight.
— 18, —	— —	65 —	1.0 —	85 —	Very heavy shower: one could only see for few yards. River in strong flood.
— 19, —	— —	68 —	— —	85 —	
— 20, —	— —	68 —	— —	95 —	
— 21, —	— —	75 —	— —	93 —	
— 22, —	— —	73 —	— —	85 —	Heavy rain-storm a few miles [away.
— 23, —	— —	72 —	— —	82 —	
— 24, —	— —	67 —	— —	87 —	
— 25, —	— —	67 —	— —	88 —	
— 26, —	— —	67 —	— —	87 —	
— 27, —	— —	70 —	— —	91 —	
— 28, —	— —	68 —	— —	92 —	Few drops.
— 30, —	— —	70 —	— —	82 —	
May 1, —	— —	64 —	— —	88 —	
— 2, —	— —	70 —	— —	80 —	Slight shower.
— 3, —	— —	66 —	— —	88 —	
— 4, —	— —	68 —	— —	92 —	
— 5, —	— —	69 —	— —	78 —	Rather dull. Raining all round, [but not here.
— 6, —	— —	72 —	— —	82 —	
— 7, —	— —	71 —	— —	92 —	Slight shower.
— 8, —	— —	72 —	— —	90 —	Little rain in afternoon.
— 9, —	— —	72 —	— —	91 —	Shower in afternoon.
— 10, —	— —	71 —	— —	90 —	Little rain.
— 11, —	— —	73 —	— —	95 —	
— 12, —	— —	69 —	— —	92 —	
— 13, —	— —	72 —	— —	89 —	
— 14, —	— —	71 —	— —	92 —	
— 15, —	— —	72 —	— —	94 —	
— 16, —	— —	72 —	4.0 —	104 —	
— 17, —	— —	73 —	1.0 —	95 —	
— 18, —	— —	70 —	— —	92 —	
— 19, —	— —	70 —	— —	94 —	
— 20, —	— —	73 —	— —	98 —	
— 21, —	— —	72 —	— —	95 —	
— 22, —	— —	70 —	— —	92 —	
— 23, —	— —	71 —	— —	98 —	
— 24, —	— —	70 —	— —	98 —	
— 25, —	— —	71 —	— —	89 —	Heavy rain for about 40 mins.
— 26, —	— —	69 —	— —	82 —	Few drops about 5 P.M. Much rain in immediate neighbourhood.
— 27, —	— —	67 —	2.0 —	90 —	
— 28, —	— —	71 —	1.0 —	89 —	
— 29, —	— —	71 —	— —	90 —	
— 30, —	— —	69 —	4.0 —	88 —	
— 31, —	— —	71 —	1.0 —	99 —	
June 1, —	— —	71 —	— —	88 —	
— 2, —	— —	71 —	— —	90 —	
— 3, —	— —	70 —	— —	90 —	
— 4, —	— —	69 —	— —	92 —	
— 5, —	— —	68 —	— —	90 —	

Date.		Morning and afternoon temperature (Fahrenheit).				Rainfall.
June	5, 1909.	6.0 A.M.	68 deg.	1.0 P.M.	90 deg.	
—	6, —	—	69 —	—	88 —	
—	7, —	—	68 —	—	91 —	
—	8, —	—	66 —	—	90 —	
—	9, —	—	68 —	—	92 —	
—	10, —	—	68 —	—	92 —	
—	11, —	—	75 —	—	95 —	
—	12, —	—	75 —	—	94 —	
—	13, —	—	73 —	—	98 —	
—	14, —	—	73 —	—	95 —	
—	15, —	—	72 —	—	93 —	
—	16, —	—	71 —	—	—	
—	17, —	—	72 —	—	92 —	
—	18, —	—	73 —	—	94 —	
—	19, —	—	73 —	—	95 —	
—	20, —	—	73 —	—	93 —	
—	21, —	—	73 —	—	90 —	
—	22, —	—	73 —	—	92 —	
—	23, —	—	71 —	3.0 —	100*	
—	24, —	—	73 —	1.0 —	95 —	Heavy shower about 6 P.M.
—	25, —	—	73 —	—	96 —	
—	26, —	—	71 —	—	90 —	
—	27, —	—	72 —	—	93 —	
—	28, —	—	71 —	—	95 —	
—	29, —	—	70 —	—	90 —	
—	30, —	—	70 —	—	89 —	

* I have a note here that the temperature usually rose to about 100 deg. about 3 P.M.

“For a further period of a little over seven months there was no rainfall at Mandera. This statement is from memory, but I am confident of its accuracy, and am very sorry I cannot find my diary to provide confirmation.”

WALTER FEATHER.

HETEROCERA.

Fam. AMATIDÆ.

273. *APISA CANESCENS* Wlk.

Mandera.—1908: June 18,—1 ♂; Sept. 15,—1 ♂. 1909
Jan. 8,—1 ♂; Jan. 12,—1 ♂; Jan. 16,—1 ♂.

Gan Libbah.—1908: June 24,—1 ♂.

283. *METARCTIA BURRA* Schaus.

1909: Apr. 20,—1 ♂.

In this and all succeeding species where no locality is mentioned, Mandera is to be understood.

Fam. ARCTIADÆ.

Subfam. NOLINÆ.

63 *c.* *NOLA CHIONEA* Hmps. n.

1908: Mar. 22,—1 ♀.

Subfam. LITHOSIANÆ.

843. *SICCIA SORDIDA* Butl.

1908: Oct. 25,—1 ♀.

Subfam. ARCTIANÆ.

1677. *MAENAS ARBORIFERA* Butl.

1908: Apr. 30,—1 ♂; Oct. 18,—1 ♀. 1909: Mar. 28,—1 ♂; Apr. 8,—1 ♂; Apr. 11,—1 ♂; Oct. 14,—1 ♂. 1910: Mar. 6,—2 ♂; Mar. 12,—1 ♂; Mar. 14,—3 ♂.

1730 *a.* *DIACRISIA DIVERSATA* Hmps. n.

1909: Sept.—1 ♀.

DIACRISIA var. near 1812. *LINEATA*, Wlk.

1909: May 10,—1 ♂.

1858 *b.* *ESTIGMENE GRISEATA*, sp. n. (Pl. I. fig. 1, ♀.)

♀. Head and thorax brownish grey, the back of head and tips of tegulæ orange-yellow, the patagia with small black spots near base; palpi black at tips; abdomen fulvous orange with lateral series of small black spots. Fore wing brownish grey; a small black spot at base of cell; black points in the angles of cell and two beyond lower angle. Hind wing white tinged with reddish brown. Underside brownish white, the costal area of both wings tinged with red-brown; hind wing with black discoidal spot.

1909: May 21,—1 ♀ (type). *Exp.* 40 millim.

2068. *TERACOTONA SUBMACULA* Wlk.

1909: Oct. 22,—1 ♂.

2088. *UTETHEISA PULCHELLA* L.

1909: May 11,—1 ♀; May 21,—1 ♂. 1910: Jan.,—1 ♂.

2094 *a.* *SECUSIO SOMALIENSIS*, sp. n. (Pl. I. fig. 2, ♀.)

♀. Head and thorax pale reddish brown tinged with grey; the vertex of head with minute black streak; the tegulæ, shoulders, and patagia near base and tips with black spots ringed with whitish; the metathorax with minute black spot; palpi brown at sides; pectus and legs whitish tinged with brown, the

former with black spot at side; abdomen brownish ochreous with dorsal and sublateral series of black spots, the ventral surface whitish tinged with brown. Fore wing pale reddish brown; a subbasal black point on costa ringed with white; obliquely placed antemedial black spots on and below costa and in cell and spots nearer the base below median nervure and above vein 1, all ringed with white; two diffused waved white medial lines, rather oblique to below the cell, then incurved; obliquely placed postmedial black spots ringed with white below veins 8 and 7, then a series of diffused white spots with minute black points on the spots below veins 5 and 4; a subterminal series of diffused white spots in the interspaces. Hind wing pale grey-brown. Underside of both wings uniform pale grey-brown.

1908: Nov. 13,—1 ♀ (type). *Exp.* 36 millim.

2098. *SECUSIO STRIGATA* Wlk.

Mandera.—**1908:** Sept. 25,—1 ♀.

Gan Libbah.—**1908:** June 25,—1 ♂; Nov. 6,—1 ♀. **1909:** Nov. 4,—2 ♀.

Fam. AGARISTIDÆ.

84. *ROTHIA AISHA* Kirby.

1909: Apr. 8,—1 ♂.

122. *ÆGOCERA BREVVITTA* Hmps.

1909: May 6,—1 ♀; May 10,—9 ♀. 1 ♀ specimen without data.

162. *TUERTA TRIMENI* Feld.

1909: Apr. 5,—1 ♂; Apr. 14,—1 ♂, 1 ♀; Apr. 20 or 21,—1 ♀.

Fam. NOCTUIDÆ.

Subfam. AGROTINÆ.

47 *a.* *CHLORIDEA ALBIVENATA*, sp. n. (Pl. I. fig. 3, ♀.)

♀. Head and thorax rufous mixed with ochreous; antennæ brownish, white towards base; palpi, pectus, legs, and abdomen ochreous irrorated with brown, the dorsum of abdomen thickly irrorated. Fore wing ochreous tinged with rufous and slightly irrorated with blackish, a stronger rufous shade along median nervure expanding towards the postmedial line; a diffused blackish streak below base of cell; a faint diffused oblique blackish antemedial line from costa to median nervure; reniform a diffused blackish spot; the veins beyond the cell slightly streaked with white to the postmedial line, which is whitish slightly defined on each side by blackish, bent outwards below costa, then minutely dentate, excurved to vein 5, then oblique, a fuscous

and rufous shade beyond it; a terminal series of black points; cilia whitish tinged with brown. Hind wing ochreous suffused with brown, the terminal area broadly suffused with blackish; a large blackish discoidal spot; cilia white, tinged with brown at base. Underside ochreous, the costal areas irrorated with brown; fore wing with some fuscous along median nervure; both wings with large black discoidal spots and black subterminal shade from below costa to above inner margin.

1909: Oct. 20,—1 ♀ (type). *Exp.* 24 millim.

56. *CHLORIDEA OBSOLETA* Fabr.

1909: Mar. 2,—1 ♀.

304. *EUXOA SPINIFERA* Hübn.

1908: Nov. 20,—1 ♀.

Subfam. *HADENINÆ*.

1799. *DIAPHONE EUMELA* Stoll.

1909: Feb. 28,—1 ♀; Apr. 8,—1 ♂; Apr. 14,—1 ♀.

1850. *CIRPHIS LOREYI* Dup.

1909: Jan. 11,—1 ♀.

Subfam. *ACRONYCTINÆ*.

3139. *PERIGEA CAPENSIS* Guen.

1908: Nov. 24,—1 ♀.

3552. *IAMBIODES INCERTA* Rothsch.

1908: June 7,—1 ♀ (in B.M.).

3623 *a.* *THALATHA MELANOSTROTA*, sp. n. (Pl. I. fig. 4, ♂.)

♂. Head and thorax white irrorated with black scales, the latter strongly tinged with rufous except the tegulæ; antennæ fulvous; palpi white, reddish brown above; pectus white; legs white and brown; abdomen red-brown mixed with some white and irrorated with black, the basal crest rufous, the anal tuft and ventral surface white. Fore wing grey, tinged with red-brown except on terminal area and irrorated with large black scales; faint traces of a medial line, oblique towards costa, then sinuous; an indistinct double dark postmedial line, very oblique towards costa, then sinuous and incurved below vein 3; a series of black points before termen. Hind wing white tinged with red-brown, the costal area and termen more strongly tinged; cilia white. Underside of fore wing suffused with brown; hind wing white, the costal area and termen to vein 2 irrorated with brown.

1909: Apr. 8,—1 ♂ (type). *Exp.* 26 millim.

3786. *CETOLA PULCHRA* B.-Baker.

1909: Apr. 6,—1 ♀; Apr. 9,—1 ♀; Apr. 14,—1 ♂.

3792 *a.* *MATOPO HETEROCHROA*, sp. n. (Pl. I. fig. 5, ♂.)

Antennæ of male bipectinate with rather long branches to apex, of female ciliated.

♂. Head and tegulæ ochreous white, the latter with slight brown lines at middle and tips; thorax bluish white slightly mixed with pale brown; palpi with the 2nd joint, except at tip, and the 3rd joint brown; frons with lateral brown bars; pectus, legs, and abdomen creamy white, the fore tibiæ and the tarsi banded with blackish. Fore wing bluish white tinged in parts with brown, especially on costal and terminal areas, the veins of terminal half with slight dark streaks; a subbasal brown point below costa; antemedial line slight, dark brown, angled outwards below costa and strongly in submedian fold and above inner margin; claviform defined by dark brown, minute; reniform faint, yellowish with slight brown centre; postmedial line slight, dark brown, defined on outer side by yellowish except towards costa, strongly bent outwards below costa, then waved, incurved below vein 4, and with a slight brown shade before it towards inner margin, some white points beyond it on costa, and slight black-brown streaks above and below vein 6 and between veins 4 and 2; cilia intersected by slight white streaks. Hind wing pure white, the terminal area slightly tinged with brown. Underside white.

♀. More strongly tinged with reddish brown; fore wing with round whitish orbicular stigma and some fiery red on outer edge of reniform and on the yellowish beyond the postmedial line; hind wing suffused with reddish brown; underside tinged with red-brown.

1908: Oct. 13,—1 ♀ (type); Nov. 24,—1 ♂ (type). 1909: Mar. 12,—1 ♀; Apr. 14,—1 ♀; Apr. 20,—1 ♀; Apr. 22,—1 ♀; Apr. 26,—1 ♀; Sept. 30,—1 ♀; Oct. 22,—1 ♀; Nov. 6,—1 ♀. *Exp.* 32–36 millim.

3878. *LAPHYGMA EXIGUA* Hübn.

1909: Jan. 15,—1 ♂, 1 ♀.

Genus ODONTORETHA, nov.

Type, *O. featheri*.

Proboscis fully developed; palpi porrect, short, slender; frons with large, conical, truncate prominence with raised edges produced to two minute teeth below and two at each side; eyes large, round; antennæ of male almost simple; thorax clothed almost entirely with scales, the metathorax with depressed crest; build slender; tibiæ slightly fringed with hair; abdomen clothed with rather rough hair, but without crests. Fore wing long and very narrow; the apex rectangular, the termen evenly curved and not crenulate; veins 3, 4 stalked; 5 from just above angle;

6 from well below upper angle; 7, 8, 9, 10 stalked; 11 from cell. Hind wing with the cell long; veins 3, 4 stalked; 5 obsolescent from just below middle of discocellulars; 6, 7 shortly stalked; 8 anastomosing with the cell near base only.

In key differs from *Prometopus* in the frontal prominence being toothed at edges and the fore wing having veins 3, 4 stalked.

3880 *a.* ODONTORETHA FEATHERI, sp. n. (Pl. I. fig. 7, ♂.)

♂. Head white; antennæ tinged with fuscous; frons with black bars at sides; palpi mostly black; thorax and abdomen grey-white mixed with some blackish; pectus, legs, and ventral surface of abdomen white, the tarsi black ringed with white. Fore wing grey-white, the terminal half with black scales mixed except a patch in and just beyond the cell from costa to vein 2; the darker area defined on inner side by a faint oblique medial line angled outwards just below the cell, with a black streak in the cell from it to the pale patch, which is somewhat constricted at discal fold. Hind wing white; a brown discoidal striga and some faint striæ on termen except towards tornus; the underside with some black on costa towards base, a rather diffused black mark on vein 8 just beyond the cell, and the costal area slightly irrorated with black towards apex.

1909: Mar. 12,—1 ♂ (type). *Exp.* 24 millim.

3989. ATHETIS LEUCONEPHRA Hmps.

1908: Sept. 24,—1 ♀; Sept. 27,—1 ♀; Oct. 13,—1 ♀.

3998 *a.* ATHETIS DISCOPUNCTA, sp. n. (Pl. I. fig. 8, ♀.)

♀. Head and thorax creamy white irrorated with rufous and a few black-brown scales; antennæ brown except at base; palpi tinged with red-brown towards tips; abdomen whitish suffused with red-brown. Fore wing white irrorated with pale red-brown and a few black-brown scales; small subbasal, antemedial, and postmedial black spots on costa; a black point just beyond the cell; traces of a postmedial line formed by red-brown and black scales arising from the costal spot, excurved from below costa to vein 4, then incurved; some minute blackish streaks on postmedial part of costa; subterminal line represented by slight blackish streaks and spots except towards costa; the terminal area tinged with rufous except at apex; a series of small black spots just before termen; cilia rufous at base, chequered rufous and white at tips. Hind wing white, the termen tinged with rufous except towards apex. Underside white, the costal and terminal areas of fore wing and apex of hind wing irrorated with rufous.

1909: Sept. 11,—1 ♀ (type). *Exp.* 28 millim.

4020 *a.* ATHETIS ECTOMELÆNA, sp. n. (Pl. I. fig. 9, ♂.)

♂. Head and thorax ochreous; antennæ brownish; palpi blackish at sides; tibiae irrorated with blackish, the tarsi blackish

with pale rings; abdomen ochreous white with diffused fuscous dorsal bands. Fore wing ochreous; a minute black subbasal spot on costa and slight point below the cell; a small black antemedial spot on costa, and traces of a sinuous line with slight black marks on it below the cell and above inner margin; two small black spots at middle of costa; a black subterminal band, broad at costa and narrowing to a point at inner margin, extending, except towards apex and tornus, to beyond the slight pale subterminal line, which is slightly angled outwards at vein 7 and excurved at middle; the termen ochreous with a series of minute black lunules; cilia whitish, tinged with brown at base. Hind wing white, with a slight brown terminal line except towards tornus; cilia ochreous at base, white at tips, and with a brown line through them towards apex. Underside white, the fore wing and costa of hind wing tinged with ochreous; fore wing with the terminal area suffused with fuscous except towards tornus; the cilia ochreous at base followed by a brown shade and the tips white; hind wing with some brown on apical part of termen.

1908: Oct. 20,—1 ♂ (type). *Exp.* 30 millim.

Genus *CONSTANTIODES*, nov.

Type, *C. pyralina*.

Proboscis absent; palpi upturned, the 2nd joint reaching to vertex of head, slenderly scaled, the 3rd moderate, thickly scaled; frons smooth, with ridge of hair above; eyes large, round; antennae of male bipectinate with moderate branches, the apex ciliated; thorax clothed almost entirely with scales, the metathorax with depressed crest; tibiae slightly fringed with hair; abdomen with dorsal crest at base only. Fore wing narrow, the apex rectangular, the termen evenly curved, crenulate; veins 3 and 5 from near angle of cell; 6 from upper angle; 9 from 10 anastomosing with 8 to form a narrow areole; 11 from cell. Hind wing with veins 3, 4 from angle of cell; 5 obsolescent from below middle of discocellulars; 6, 7 from upper angle; 8 anastomosing with the cell near base only.

In key differs from *Plusilla* in the fore wing being narrow with the termen crenulate.

4030 *a.* *CONSTANTIODES PYRALINA*, sp. n. (Pl. I. fig. 35, ♂.)

♂ ♀. Head and thorax white mixed with some red-brown; palpi with some dark brown towards extremity of 2nd joint; abdomen creamy white, dorsally tinged with brown. Fore wing creamy white tinged in parts with brown and slightly irrorated with black, the termen yellowish tinged with rufous; a slight curved blackish subbasal line from costa to vein 4; antemedial line reddish brown defined on inner side by white, oblique to submedian fold, then almost obsolete; some white in end of cell; reniform slightly defined by red-brown, large, somewhat angled

inwards on median nervure, a red-brown shade beyond it from costa beyond the postmedial line followed by some white; postmedial line blackish, oblique towards costa, then slightly waved, at vein 3 retracted to inner edge of reniform, then oblique to inner margin, the veins beyond it with slight black streaks except towards costa; some oblique white and dark striæ on costa towards apex; subterminal line white, slightly waved from below costa to vein 4, then oblique; some rufous at apex; a waved blackish terminal line. Hind wing creamy white; a slight waved brown terminal line; the underside with the apical area irrorated with a few red-brown scales.

1908: June 1,—1 ♀ (in B.M.); Sept. 21,—1 ♂ (type). 1909: Mar. 11,—1 ♀; Apr. 7,—1 ♂. *Exp.* 22 millim.

4103 *a.* *ETHIOPICA IGNECOLORA*, sp. n. (Pl. I. fig. 10, ♀.)

Antennæ of female bipectinate.

♀. Head and thorax fiery rufous; antennæ black; pectus and legs rufous; tarsi dark brown ringed with white; abdomen ochreous brown, the ventral surface whitish tinged with rufous. Fore wing fiery rufous; traces of a curved deeper red antemedial line; a whitish point in middle of cell; reniform defined by whitish points; postmedial line indistinct, deep red, oblique towards costa, then slightly waved, excurved to vein 4, then incurved; some slight whitish points beyond it on costa; subterminal line represented by a slight whitish striga from costa and whitish points above and below vein 6 further from termen; a terminal series of slight whitish points. Hind wing white, the costal area, and terminal area to vein 2, tinged with pale brown. Underside of fore wing brownish white, the costal area red; hind wing with the costal edge red.

1909: Dec. 15,—1 ♀ (type). *Exp.* 26 millim.

4103 *b.* *ETHIOPICA PHÆOCAUSTA*, sp. n. (Pl. I. fig. 11, ♀.)

♀. Head, thorax, and abdomen deep purplish red tinged with brown; antennæ black; palpi black-brown except at tips; tarsi black-brown with slight pale rings. Fore wing deep purplish red tinged with brown; a very indistinct sinuous brownish antemedial line; reniform red incompletely defined by ochreous, narrow; postmedial line indistinct, dark, oblique to vein 6, then dentate and incurved below vein 4, some minute pale points beyond it on costa, a terminal series of ochreous points. Hind wing white tinged with brown, the cilia pure white at tips. Underside of fore wing pale brown; hind wing white, the costal half suffused with brown.

1909: May 9,—1 ♀ (type); May 10,—1 ♀. *Exp.* 26 millim.

4524. *ELYDNA BISIGNATA* Hmps.

1909: May 12,—1 ♀.

4676 *a.* *RABILA ALBIVIRIDIS*, sp. n. (Pl. I. fig. 13, ♂.)

Antennæ of male laminate and minutely ciliated.

♂, ♀. Head, thorax, and abdomen white slightly mixed with brownish; antennæ tinged with ochreous. Fore wing pale yellow-green irrorated with white, the costal area whiter to beyond middle. Hind wing white tinged with brown. Under-side white; fore wing suffused with brown, except the costa and inner area which are irrorated with brown; hind wing with the costal and terminal areas irrorated with brown.

Ab. 1. ♀. Fore wing with deeper green patch with a golden tinge and defined by whitish on inner basal area, its outer edge rounded and a similar small round spot distinctly defined by white before tornus.

1908: May 28,—1 ♀; June 2,—1 ♂; June 21,—1 ♂ (type).

1909: Apr. 6,—1 ♀; Apr. 8,—1 ♂; Apr. 22,—1 ♂; Apr. 23,—1 ♀; May 8,—1 ♀ (B.M.); May 10,—2 ♂; Sept. 16,—1 ♀ ab. (B.M.). Year? : May,—1 ♂. *Exp.* 20–24 millim.

4742 *a.* *ACRAPEX ALBICOSTATA*, sp. n. (Pl. I. fig. 14, ♂.)

♂. Head whitish mixed with dark brown, the antennæ ringed with brown towards base, thorax white tinged with red-brown, the tegulæ with slight brown medial line; pectus, legs, and abdomen white, the fore legs brown in front. Fore wing white tinged and irrorated with red-brown, the costal edge brown, the inner half dark brown to the postmedial line, extending except at base to discal fold and leaving some yellow on inner margin, met at the postmedial line by an oblique brown fascia from termen below apex; subbasal and antemedial slight double oblique brown striæ from costa; a black point in middle of cell and slight striga on discocellulars with point beyond it; postmedial line slight, brown, strongly bent outwards below costa, then slightly waved, excurved to vein 4, then incurved and double towards inner margin, the area beyond it with black streaks between veins 8 and 4; an oblique slightly waved brown subterminal line below the oblique fascia; a terminal series of black points. Hind wing pure white. Under-side white, the costal area of fore wing tinged with ochreous and irrorated with red-brown.

1908: Sept. 26,—1 ♂ (type). *Exp.* 22 millim.

4755. *SESAMIA CONIOTA* Hmps.

1909: Jan. 12,—1 ♀.

Genus *PACHYCOA*.

Type, *P. olivacea*.

Proboscis fully developed; palpi obliquely upturned, slender, the 2nd joint reaching to about vertex of head and slightly fringed with hair behind at extremity, the 3rd short and thickly scaled; frons with flattened corneous plate at middle covered by a tuft of hair above and corneous plate below; eyes

rather small, round; antennæ of female somewhat laminate and almost simple; thorax thickly clothed with rough scales and hair, the metathorax with spreading crest; tibiæ slightly fringed with hair; abdomen without crests. Fore wing thickly clothed with rough scales, the apex rounded, the termen evenly curved and not crenulate; veins 3 and 5 from near angle of cell; 6 from below upper angle; 7 from angle; 8, 9, 10 stalked; 11 from cell. Hind wing with veins 3, 4 very shortly stalked; 5 somewhat obsolescent from well below middle of discocellulars; 6, 7 from upper angle; 8 anastomosing with the cell near base only.

In key differs from *Xantholepis* in the abdomen being without crests.

4824 a. *PACHYCOA OLIVACEA*, sp. n. (Pl. I. fig. 12, ♀.)

♀. Head whitish tinged with olive-brown and the frontal tuft with rufous; antennæ and palpi brown; thorax olive-brown, the metathoracic crest darker brown; abdomen olive-brown; pectus, legs, and ventral surface of abdomen whitish suffused with brown. Fore wing olive-brown with a reddish tinge except on terminal area; the 1st line almost medial, slight, whitish, oblique to subcostal nervure, then erect; postmedial line slight, whitish, excurred to vein 4, then oblique; cilia whitish tinged with brown and chequered with chocolate-brown at tips. Hind wing dark brown, the cilia silvery white at tips. Underside brown, the costal and terminal areas of fore wing and the hind wing irrorated with white.

1909: Sept. 16,—1 ♀ (type). *Exp.* 22 millim.

Genus *ACRORIESIS*, nov.

Type, *A. ignifusa*.

Proboscis fully developed; palpi obliquely upturned, slender, the 2nd joint reaching to above vertex of head, the 3rd short, thickly scaled; frons with flattened corneous plate at middle covered by a tuft of hair above and corneous plate below; eyes large, round; antennæ of female somewhat laminate and almost simple; thorax clothed with scales and hair mixed, the metathorax with spreading crest; tibiæ slightly fringed with hair; abdomen without crests. Fore wing with the apex rounded, the termen evenly curved and not crenulate; veins 3 and 5 from near angle of cell; 6 from upper angle; 7, 8 and 9, 10 stalked; 11 from cell. Hind wing with veins 3, 4 from angle of cell; 5 somewhat obsolescent from well above angle; 6, 7 from upper angle; 8 anastomosing with the cell near base only.

In key differs from the other genera without an areole in the fore wing having veins 7, 8 and 9, 10 stalked.

4824 b. *ACRORIESIS IGNIFUSA*, sp. n. (Pl. I. fig. 6, ♀.)

♀. Head and thorax whitish suffused with cupreous red; pectus and legs white, the latter tinged with brown; abdomen brown, the ventral surface white tinged with rufous towards extremity. Fore wing pale grey-brown suffused with cupreous

red to the postmedial line except towards base; a subbasal chocolate-brown spot on inner margin and streak in end of cell; postmedial line double, brown filled in with white, very oblique from costa to vein 6 towards termen, then excurved to vein 4, then very inwardly oblique, with fiery red beyond it, except between veins 6 and 4, followed by a white line; cilia with fine whitish line at base and white tips. Hind wing white tinged with brown, the cilia pure white. Fore wing grey-brown, the costa white towards apex; hind wing white with small brown discoidal spot and curved postmedial line.

1909: Sept. 16,—1 ♀ (type). *Exp.* 18 millim.

4857 *a.* *EUTERPIODES PICTIMARGO*, sp. n. (Pl. I. fig. 15, ♂.)

Antennæ of male laminate and almost simple.

♂. Head and tegulæ bright rufous; thorax ochreous; fore and mid tibiæ and the tarsi red-brown ringed with white; abdomen ochreous white, the 2nd to 4th segments dorsally tinged with red-brown. Fore wing ochreous white, the area beyond the antemedial line from costa to below the cell and vein 3 suffused with bright rufous to termen; subbasal line black with some rufous before it on costa, sinuous, from costa to submedian fold; antemedial line black, oblique, sinuous, incurved above vein 1; claviform defined by red-brown at extremity; orbicular defined by red-brown, round; reniform with whitish centre and annulus defined by red-brown; a sinuous red-brown medial line; postmedial line black, slightly defined on outer side by white on the rufous area, strongly bent outwards below costa, slightly incurved at discal fold, incurved below vein 4 to below end of cell and excurved above vein 1, some white points beyond it on costa; subterminal line slight, white, defined on inner side by small rather dentate black marks from costa to vein 3, angled outwards at veins 7, 6 and inwards at discal fold, then minutely dentate, a crimson patch beyond it at apex with oblique black striga from apex; a terminal series of minute black lunules defined on inner side by white, more strongly towards apex; cilia pale rufous with a reddish-brown line near base. Hind wing silky white; the underside with the costal area irrorated with red-brown and with faint red-brown postmedial shade from costa.

♀. Thorax, abdomen, and the basal and inner areas of fore wing tinged with rufous; hind wing red-brown, the cilia whitish.

1908: Aug. 15,—1 ♀; Sept. 26,—1 ♂ (type). **1909:** Mar. 15,—1 ♂; Apr. 8,—1 ♀ (type). *Exp.* ♂ 20, ♀ 22 millim.

4857 *b.* *EUTERPIODES CROCEISTICTA*, sp. n. (Pl. I. fig. 16, ♂.)

♂. Head and thorax creamy white; frons and palpi tinged with orange, the latter with some black at side of 2nd joint; patagia with orange patches; fore and mid tibiæ tinged with

orange, the tarsi orange ringed with white; abdomen white, suffused with dark brown except at base and extremity. Fore wing creamy white; antemedial line represented by orange striæ from costa and inner margin, a black point above submedian fold and orange point below it, inwardly oblique; postmedial line represented by an orange striga from costa, black points above and below vein 5, and below the end of cell by a black point above submedian fold, black and orange point below it, and orange striga from inner margin. Hind wing silky white with a very faint brown tinge. Underside of fore wing suffused with brown.

1909: Mar. 26,—1 ♂ (type); May 8,—1 ♀; May 10,—1 ♂. *Exp.* 14 millim.

4885 *a.* PARATUERTA NANA, sp. n. (Pl. I. fig. 17, ♂.)

♀. Head and thorax white with some brown scales; antennæ ringed with brown towards base; abdomen white dorsally irrorated with brown, the double basal crest with some blackish scales with a metallic gloss. Fore wing white irrorated with brown, the terminal area more thickly irrorated; a sinuous black-brown streak in submedian fold to the postmedial line, with the area below it and also the area from just before the postmedial line to the subterminal line chocolate-brown mixed with grey; antemedial line hardly traceable to submedian fold, then blackish and strongly angled outwards above inner margin; a faint diffused reddish-brown spot in end of cell almost conjoined to a similar discoidal spot; postmedial line black-brown, obliquely curved and slightly waved from costa to the streak in submedian fold where it terminates, the brown before it angled inwards at discal fold; subterminal line black-brown, obliquely curved and slightly waved, angled inwards at vein 1; a fine dark terminal line. Hind wing ochreous yellow, the inner area tinged with reddish brown; the postmedial area reddish brown to near termen, which is yellowish irrorated with brown; a terminal series of brown striæ. Underside of both wings white, the terminal areas broadly suffused with brown, the costal area of fore wing irrorated with brown.

♂. Fore wing with the costal area and disk grey irrorated with brown and hardly paler than the inner and terminal areas, the orbicular and reniform defined by dark brown, the latter faintly on outer side, the former round; hind wing brownish ochreous.

1909: Apr. 11,—1 ♂ (type); Apr. 30,—1 ♀ (type). *Exp.* ♂ 26, ♀ 30 millim.

Subfam. ERASTRIANÆ.

5068 *b.* ENISPA FLAVIPARS, sp. n. (Pl. I. fig. 18, ♂.)

♂. Head and thorax rufous; pectus, legs, and abdomen whitish tinged with brown, the last with some rufous at base of

dorsum. Fore wing irrorated with silvery scales, the costal half rufous to beyond the cell, the rest of wing pale olive-green banded with pale yellow; an indistinct interrupted antemedial band; a small brown spot in middle of cell and curved discoidal striga; the postmedial line dark and bent outwards below costa with a yellow spot before it at costa, a yellow spot at discal fold and incurved band from vein 4 to inner margin, some yellowish points beyond it on costa; an interrupted maculate subterminal yellowish band. Hind wing irrorated with silvery scales, pale olive-green with the terminal area pale yellow; the underside pale yellow.

1908: Oct. 31,—1 ♂ (type). **1909:** Mar. 12,—1 ♂. *Exp.* 16 millim.

5142. *EUBLEMMA ADMOTA* Feld.

1909: Oct. 11,—1 ♀.

5144. *EUBLEMMA REDUCTA* Butl.

1908: June 1,—1 ♂; Oct. 13,—3 ♂; Oct. 23,—1 ♂; Nov. 17,—1 ♂. **1909:** May 8,—1 ♀; May 10,—1 ♂, 1 ♀.

5149. *EUBLEMMA NIGRIVITTA* Hmps.

Mandera.—**1908:** Sept. 20,—1 ♂; Oct. 11,—1 ♂. **1909:** Mar. 12,—1 ♂; Mar. 26,—1 ♂.

Hargaisa.—**1908:** Oct.,—1 ♂.

5158 *a.* *EUBLEMMA EREMOCHROA*, sp. n. (Pl. I. fig. 19, ♂.)

♂. Head, thorax, and abdomen ochreous slightly tinged with rufous; antennæ tinged with fuscous; palpi and fore legs blackish. Fore wing ochreous tinged and irrorated with rufous and with a few blackish scales; the costal edge blackish towards base; traces of a waved rufous antemedial line; minute black points in middle of cell and on discocellulars sometimes present; traces of a rufous medial line, oblique to the discocellulars, then inwardly oblique; postmedial line indistinct, rufous, oblique towards costa, then inwardly oblique, very slightly waved and sometimes with some blackish scales on it; some faint pale and rufous marks on costa towards apex; an oblique rufous subterminal shade with a series of minute white points on it, sometimes with some black scales on their outer edges and with one to three black points towards costa; a terminal series of black points with more prominent spot at submedian fold. Hind wing white with a faint rufous tinge; traces of a sinuous rufous postmedial line; a punctiform blackish terminal line. Underside of fore wing suffused with red-brown except the marginal areas; hind wing with the costal area irrorated with rufous.

♀. Fore wing more strongly suffused with rufous, the white points on the subterminal line usually obsolete; hind wing more strongly tinged and irrorated with rufous.

1908: July 19,—1 ♀; July 31,—2 ♂. **1909:** Jan. 9,—1 ♀; **PROC. ZOOL. SOC.**—1916, No. VIII.

Jan. 14,—1 ♂ ; Jan. 15,—1 ♀ ; Jan. 17,—1 ♀ ; Jan. 18,—1 ♂ (type) ; Jan. 19,—1 ♂ , 1 ♀ (type) ; Mar. 30,—1 ♂ . *Exp.* 18–22 millim.

5214. *EUBLEMMA SCITTULA* Rmbr.

1903 : June 29,—1 ♀ ; Sept. 16,—1 ♀ ; Sept. 17,—1 ♀ ; Oct. 28,—1 ♀ ; Nov. 17,—1 ♂ ; Nov. 19,—1 ♂ . 1909 : Jan. 19,—1 ♀ ; Feb. 22,—1 ♀ ; Mar. 13,—1 ♂ .

5282 *a.* *EUBLEMMA OCHRICOSTA*, sp. n. (Pl. I. fig. 20, ♀.)

♀. Head white, the antennæ tinged with ochreous, the palpi with grey-brown ; thorax whitish tinged with grey-brown ; pectus and legs white, the fore legs tinged with grey-brown, the mid and hind legs with ochreous ; abdomen ochreous white. Fore wing ochreous white suffused and irrorated with grey-brown, the costal area broadly ochreous ; black points in cell towards extremity and on discocellulars with a slight white streak between them ; some very slight white streaks in the interspaces of terminal area, the streak in discal fold extending to near end of cell. Hind wing white with an ochreous tinge.

1909 : Feb. 23,—1 ♀ (type). *Exp.* 18 millim.

5282 *b.* *EUBLEMMA ARENOSTROTA*, sp. n. (Pl. I. fig. 21, ♂.)

♂. Head white, the antennæ and palpi tinged with ochreous ; thorax whitish mixed with grey-brown ; pectus, legs, and abdomen white tinged with ochreous. Fore wing ochreous irrorated with white and grey-brown except on terminal area, the ochreous forming diffused fasciæ on median nervure and above vein 2 to the oblique grey-brown subterminal shade ; the costal edge white ; minute brown spots on each side of discocellulars ; some slight brown points on termen ; cilia white and grey-brown with a fine white line at base. Hind wing white slightly tinged with ochreous. Underside of both wings almost pure white.

1909 : Jan. 20,—1 ♂ (type). *Exp.* 20 millim.

5296. *EUBLEMMA CONISTROTA* Hmps.

1908 : Aug. 24,—1 ♀ .

5320 *a.* *TOANA NIGRILINEATA*, sp. n. (Pl. I. fig. 22, ♂.)

♂ ♀. Head, thorax, and abdomen pale grey-brown ; antennæ ringed with black ; palpi, frons, and fore legs black-brown. Fore wing pale brownish grey slightly irrorated with dark brown ; a small subbasal black spot on costa ; antemedial line strong, black, oblique to submedian fold, then incurved to inner margin ; a slight brownish medial line, excurved beyond lower angle of cell and above inner margin ; postmedial line strong, black, arising from the same point on costa as the medial line, oblique and sinuous to vein 4, then inwardly oblique to submedian fold and excurved above inner margin ; traces of a brownish subterminal

line; a strong slightly waved black terminal line; cilia with fine brown lines through them. Hind wing whitish tinged and irrorated with brown; postmedial line almost obsolete on costal half, then black, oblique to vein 4, then inwardly oblique to submedian fold and oblique to inner margin; a black terminal line. Underside whitish tinged with red-brown; hind wing with slight brown discoidal striga.

1909: Mar. 22,—1 ♂ (type); Mar. 26,—1 ♀. *Exp.* 18 millim.

5576 *a.* *CHIONOXANTHIA LEUCOPHÆA*, sp. n. (Pl. I. fig. 23, ♂.)

♂ ♀. Head, thorax, and abdomen grey-white mixed with brown; palpi black-brown ringed with white. Fore wing grey-white suffused with brown; a slight sinuous blackish subbasal line from costa to submedian fold; antemedial line double, blackish filled in with white and defined on inner side by white, sinuous, a black streak beyond it in submedian fold; orbicular white defined by black, round, some black in the cell between it and the white discoidal bar; postmedial line brown defined on each side by white, obliquely excurved from costa to vein 4, then incurved; subterminal line whitish defined on inner side by diffused brown forming a dark patch on costal area, angled inwards at discal fold, excurved at middle, then incurved and slightly waved; a terminal series of blackish strigæ. Hind wing whitish suffused with brown; the underside white irrorated with brown, a small brownish discoidal spot, curved postmedial line, a diffused subterminal line.

1908: May 28,—2 ♀ (1 in B.M.); June 1,—1 ♂ (type); June 2,—1 ♀. *Exp.* 16 millim.

5589 *a.* *CEDICODIA STRIGIPENNIS*, sp. n. (Pl. I. fig. 24, ♂.)

♂. Head and thorax red-brown slightly mixed with whitish; antennæ dark brown; palpi at base and the base of 3rd joint white; abdomen grey irrorated with brown; pectus and ventral surface of abdomen white tinged with brown. Fore wing red-brown tinged with grey and irrorated with blackish forming obscure streaks on the veins and above and below submedian fold, except on the terminal area which is slightly paler except at middle and tornus; an indistinct waved brown antemedial line, double at costa; a black discoidal striga with point above it on costa; postmedial line brown, defined on inner side by whitish towards costa, oblique to vein 6, then slightly waved and incurved below vein 4; the postmedial area rather darker brown with some whitish points on costa; subterminal line white defined on inner side by brown, very slightly excurved below vein 7 and at middle; a terminal series of minute black lunules. Hind wing pale red-brown, the cilia white tinged with red-brown at base; the underside white, the costal and terminal areas irrorated with brown, the apex suffused with brown, traces of sinuous postmedial and subterminal lines.

1908: Oct. 15,—1 ♂ (type). *Exp.* 20 millim.

5589 *b*. *EDICODIA LIMBATA* Butl.

1908: Apr. 28,—1 ♂; May 2,—1 ♀; May 4,—2 ♀; July 16,—1 ♀ (B.M.); July 17,—1 ♂; July 24,—1 ♀; Aug. 15,—1 ♂, 1 ♀; Sept. 13,—1 ♀; Sept. 15,—1 ♀; Sept. 16,—1 ♀; Sept. 23,—1 ♀; Sept. 25,—1 ♀; Sept. 26,—1 ♀; Sept. 27,—1 ♂, 1 ♀; Sept. 29,—1 ♀; Sept. 30,—1 ♀; Oct. 1,—1 ♀; Oct. 3,—1 ♂; Oct. 4,—1 ♀ (B.M.); Oct. 11,—1 ♀; Oct. 13,—1 ♂; Oct. 14,—1 ♀; Oct. 18,—1 ♀ (B.M.); Nov. 17,—1 ♀. **1909:** Jan. 17,—1 ♀; Jan. 19,—1 ♂ (B.M.); Feb. 22,—1 ♂; Mar. 10,—1 ♀; Mar. 11,—1 ♂; Apr. 8,—1 ♂, 1 ♀; Apr. 10,—1 ♂, 1 ♀; May 8,—1 ♂ (B.M.); Nov. 23,—1 ♂. **1910:** Jan. 12,—1 ♀.

5589 *c*. *EDICODIA MELANOGRAPHIA*, sp. n. (Pl. I. fig. 25, ♀.)

♀. Head, thorax, and abdomen pale red-brown; antennæ blackish; palpi except at tips, pectus, legs, and ventral surface of abdomen white, the fore and mid tibiæ tinged with brown, the tarsi brown ringed with white. Fore wing pale red-brown; a black point on costa near base, some scales in base of submedian fold and a slight patch of scales on the costa before the antemedial line, which is black, waved; a black discoidal striga, its lower extremity touching the sinuous blackish medial line, which is excurved to lower angle of cell; postmedial line blackish, approximated to the medial line, slightly waved, oblique to vein 5, then inwardly oblique; subterminal line rather diffused, black, very slightly excurved below vein 7 and at middle; some black scales on termen. Hind wing pale red-brown, the termen rather darker red-brown to vein 2; cilia white slightly tinged with rufous. Underside white tinged with rufous.

1909: Apr. 10,—1 ♀ (type). *Exp.* 24 millim.

5633 *a*. *OZARBA SEMITORRIDA*, sp. n. (Pl. I. fig. 26, ♂.)

♂. Head ochreous brown; thorax red mixed with leaden grey-brown; abdomen pale ochreous; palpi, pectus, legs, and ventral surface of abdomen white, the fore and mid tibiæ and tarsi banded with brown. Fore wing deep red suffused with dark leaden grey, especially towards costa, to the reniform and postmedial line, the rest of wing white tinged with red-brown and with a red patch on postmedial part of costa; minute subbasal white points on costa, in and below the cell; traces of a waved antemedial line defined on inner side by a whitish striga from costa; a white point in middle of cell; reniform white with pale brownish centre, narrow and oblique; postmedial line treble, red-brown filled in with white, obliquely excurved from costa to vein 4, then incurved, touching the upper and lower extremities of the reniform, three white points beyond it on the costal patch; subterminal line white defined on inner side by brown, excurved below vein 7 and at middle; a dark brown terminal line; cilia with brown shades at discal and submedian folds. Hind wing whitish suffused with reddish brown, the cilia whiter. Underside whitish tinged with red-brown except on inner area of hind wing.

♀. Head, thorax, and basal half of fore wing much redder, sometimes crimson-red and with the markings of outer half of fore wing crimson-red.

1908: Sept. 22,—1 ♂; Sept. 30,—1 ♀ (type); Oct. 18,—1 ♀; Oct. 22,—1 ♂ (type). 1909: Mar. 24,—1 ♀. *Exp.* ♂ 18, ♀ 20 millim.

5635 *a.* OZARBA ENDOSCOTA, sp. n. (Pl. I. fig. 27, ♀.)

♂ ♀. Head and thorax ochreous, the head between antennæ and patagia with deep red patches, the patagia with black-brown stripes above; antennæ dark brown; pectus and legs white, the fore legs dark brown in front, the tarsi dark brown ringed with white; abdomen white, dorsally suffused with brown. Fore wing with the basal half ochreous tinged with red-brown, the area below the cell suffused with dark brown except at base, the rest of wing grey-white irrorated with dark brown; slight brown marks on costa towards base; an oblique antemedial brown striga from costa and sinuous line from cell to inner margin defined on inner side by whitish and with short brown streaks before it in submedian fold and above inner margin; a brown spot in end of cell and whitish discoidal striga; a small black spot on costa above end of cell; postmedial line hardly traceable, excurved to vein 4, then incurved, some black suffusion beyond it on costa; subterminal line white, curved, a blackish patch beyond it at discal fold; a terminal series of minute blackish spots. Hind wing whitish strongly suffused with brown; the underside white irrorated with brown, the terminal area suffused with brown, a small blackish discoidal spot and curved postmedial line.

1908: Oct. 11,—1 ♀ (type); Nov. 22,—1 ♂. *Exp.* 20 millim.

5637. OZARBA CONSANGUIS Hmps. n.

1908: Oct. 17,—1 ♀; Oct. 25,—1 ♀. 1909: Apr. 7,—1 ♀; Apr. 8,—1 ♀.

5637 *a.* OZARBA HEMIPYRA, sp. n. (Pl. I. fig. 28, ♀.)

♀. Head whitish mixed with blackish, the upper part of frons, antennæ, and palpi blackish, the last with whitish ring at extremity of 2nd joint; thorax black with some reddish scales; pectus and legs ochreous white, the fore legs with some black in front, the tarsi banded with blackish; abdomen reddish ochreous irrorated with black, the basal crest and a bar before the anal tuft black, the ventral surface ochreous. Fore wing black slightly mixed with red to the medial line, the rest of wing fiery rufous with a slight greyish tinge on terminal area; subbasal line black slightly defined by red, waved, from costa to submedian fold; antemedial line black slightly defined on inner side by red at costa and inner margin, waved; medial line closely approximated to the antemedial line, black slightly defined on outer side by white, incurved just below median nervure, a black point beyond

it on costa; postmedial line only defined by a deeper rufous shade on its outer side, excurved to vein 4, then incurved, some whitish points beyond it on costa; subterminal line whitish defined on inner side by a deep rufous shade, excurved below vein 7 and at middle, then waved, some deep rufous beyond it at discal and submedian folds; a terminal series of minute deep rufous lunules. Hind wing whitish suffused with brown and with a fine brown terminal line; cilia paler. Underside of fore wing whitish suffused with brown and with some reddish ochreous at middle of costa; hind wing whitish irrorated with brown and with a small dark discoidal spot.

1908: Oct. 2,—1 ♀ (type). *Exp.* 20 millim.

5638. OZARBA HEMIMELÆNA Hmpsn.

1909: Mar. 21,—1 ♀; Mar. 28,—2 ♀; Apr. 7,—1 ♂; Oct. 5,—1 ♀.

5639 *a.* OZARBA HEMISARCA, sp. n. (Pl. I. fig. 29, ♂.)

♂. Head, thorax, and abdomen ochreous with a faint rufous tinge; palpi except at tips, pectus, legs, and ventral surface of abdomen white, the fore and mid tibiae ochreous, the tarsi ochreous ringed with white. Fore wing with the basal half ochreous slightly tinged with rufous, the terminal half white slightly tinged with olive-brown; two slight rufous marks on costa towards base; traces of a waved rufous antemedial line with a small deep rufous spot at costa; a red-brown medial line, oblique and sinuous to lower angle of cell, then slightly incurved, with minute blackish spots on it at costa and upper angle of cell and with the area between it and the closely approximated white postmedial line rufous, this line oblique to vein 4, then incurved; subterminal line whitish, defined on inner side by brown towards costa, slightly angled inwards below costa and incurved below vein 3; a black-brown spot at apex and terminal series of points; cilia tinged with red except at apex. Hind wing ochreous white, the area beyond lower angle of cell with a reddish tinge, the termen tinged with brown towards apex; cilia white. Underside ochreous white.

1903: Nov. 19,—1 ♂ (type). *Exp.* 18 millim.

5639 *b.* OZARBA EXOLIVACEA, sp. n. (Pl. I. fig. 30, ♂.)

♂. Head and tegulae pale reddish ochreous; antennae brown; thorax white slightly tinged with brown; pectus and legs ochreous white, the fore tibiae and the tarsi brown ringed with white; abdomen ochreous tinged with brown. Fore wing white irrorated with blackish scales, the terminal half faintly tinged with olive-green except at apex, the costa suffused with brown towards base; an indistinct double waved brownish antemedial line; an oblique dark brown medial shade diffused to the postmedial line and on postmedial costal area; reniform with

rufous centre and white annulus, narrow, oblique, and constricted at middle, a whitish patch above it on costa; postmedial line double, dark, oblique towards costa, then excurved to vein 4, then incurved, three white points beyond it on costa; subterminal line whitish defined on inner side by brown, slightly excurved below vein 7 and at middle; a slightly waved brown terminal line; cilia with series of brown marks except at apex. Hind wing ochreous suffused with reddish brown especially towards termen. Underside white irrorated with brown; fore wing tinged with ochreous except the inner area.

♀. Head, thorax, and abdomen ochreous; fore wing with the basal half tinged with ochreous, the terminal half suffused with pale olive-green, the medial shade narrower and not diffused to the postmedial line except below the cell or on the postmedial costal area.

1908: Sept. 22,—1 ♀ (type); Oct. 15,—1 ♂ (type). *Exp.* 22 millim.

5639 *c.* OZARBA MESOZONATA, sp. n. (Pl. I. fig. 31, ♂.)

♂ ♀. Head, thorax, and abdomen white faintly tinged with brown; antennæ brown; palpi brown at sides except at extremities of 2nd and 3rd joints; tarsi black-brown ringed with white. Fore wing white, the basal area faintly tinged with brown, the terminal area suffused with rufous; two slight dark marks on costa near base; a broad chocolate-brown medial band edged by black lines defined by white, narrower towards costa and slightly constricted in the cell; some whitish points on costa and a brown patch on costal area before the faint brownish subterminal line, which is slightly excurved at middle; a terminal series of black striæ slightly defined on inner side by white; cilia dark brown irrorated with grey, white at apex. Hind wing ochreous white tinged with brown; a fine brown terminal line. Underside white tinged with reddish ochreous.

1908: Sept. 19,—1 ♀; Sept. 21,—1 ♂; Sept. 22,—1 ♀; Oct. 13,—1 ♂ (type). 1909: Apr. 12,—1 ♀. *Exp.* 16-20 millim.

3639 *d.* OZARBA ENDOPLAGA, sp. n. (Pl. I. fig. 32, ♂.)

♂ ♀. Head and thorax ochreous white; antennæ brown; abdomen ochreous tinged with brown; palpi, pectus, legs, and ventral surface of abdomen white, the palpi tinged with brown towards base, the fore and mid tibiae suffused with brown, the tarsi brown ringed with white. Fore wing creamy white suffused with rufous especially on terminal half; a large conical chocolate-brown patch defined by white on medial area from below costa to inner margin, with slight black streak above it on costa in the male; some whitish points on postmedial part of costa and some brown on costa before apex; a black-brown terminal line defined on inner side by pale yellow which expands towards costa; cilia dark brown with a greyish tinge. Hind wing white tinged with

reddish brown especially in female, the cilia whiter. Underside ochreous white tinged with brown.

1908: Sept. 27,—1 ♀; Oct. 11,—1 ♀ (B.M.). 1909: Apr. 19,—1 ♂ (type); Nov. 7,—1 ♀. *Exp.* 20 millim.

5656. *OZARBA SANCTA* Staud.

1908: June 29,—1 ♂.

5685. *OZARBA PHÆA* Hmps.

1908: Feb. 11,—1 ♂.

5713. *AMYNA OCTO* Guen.

1908: Jan. 30,—1 ♂. 1909: Apr. 7,—1 ♂; Apr. 30,—1 ♀.

5718. *AMYNA PUNCTUM* Fabr.

1908: May 29,—1 ♂. 1909: Mar. 14,—2 ♀; Apr. 6,—1 ♂, 1 ♀; June 25,—1 ♂.

5891. *EUSTROTIA MIANOIDES* Hmps.

1909: Apr. 7,—3 ♀.

5942 *a.* *EULOCASTRA ARGYROSTROTA*, sp. n. (Pl. I. fig. 33, ♂.)

♂ ♀. Head and thorax ochreous slightly tinged with rufous; antennæ reddish brown; palpi brown except at tips; tibiæ and tarsi banded brown and white; abdomen brown with white segmental lines, the ventral surface ochreous white irrorated with brown. Fore wing with the basal half ochreous slightly tinged with rufous, the terminal half suffused with red-brown and black-brown and with patches of silver scales; slight subbasal and antemedial brown marks on costa and traces of a sinuous antemedial line with some silvery scales beyond it; a sinuous black medial line defining the inner edge of the dark area; an ochreous discoidal striga with some black before it; postmedial line black defined on outer side by ochreous, more strongly at costa, oblique from below costa to vein 6, slightly incurved at discal fold, oblique and slightly waved below vein 4, an oblique brown line beyond it towards costa; subterminal line represented by silver scales defined on inner side by blackish, forming diffused marks below costa and at middle, excurved below vein 7 and at middle; a terminal series of black striæ slightly defined on inner side by white; cilia with white patches at apex and discal fold. Hind wing whitish suffused with fuscous brown; the underside bluish white irrorated with fuscous brown, the terminal area more suffused with fuscous, a small blackish discoidal spot and curved postmedial line.

1908: Sept. 21,—1 ♀; Oct. 15,—1 ♀; Oct. 24,—1 ♂ (type). Year?: Oct. 25,—1 ♂. *Exp.* 16 millim.

5984. *LOPHORACHE FULVIRUFA* Hmps.

1909: Apr. 5,—1 ♀.

6081. HOPLOTARACHE NUBILA Hmps.

1908: Sept. 21,—1 ♀.

6081 *a.* HOPLOTARACHE ECTORRIDA, sp. n. (Pl. I. fig. 36, ♂.)*Hoplotarache nubila*, ab. 1, Hmps. Cat. Lep. Phal. B.M. x. p. 715.

♂. Head and thorax white, the dorsum of thorax with black scales mixed except in front; antennæ fuscous; palpi black at tips, the frons with lateral black bars; tarsi black ringed with white; abdomen creamy white with dorsal fuscous segmental bands, the ventral surface white. Fore wing white; subbasal line defined on each side by grey, sinuous, from costa to median nervure; grey streaks on costa and above vein 1 before the antemedial line, which is defined on each side by grey, waved, some grey beyond it below median nervure; small dark grey annuli in middle of cell and on discocellulars; an oblique dark grey striga from middle of costa, spot above median nervure and waved black line from cell to inner margin; an oblique dark grey postmedial striga from costa, two black strigæ beyond the cell with some grey before them and a waved black line from lower angle of cell to inner margin; the terminal area chocolate-brown, leaving an oblique wedge-shaped white patch on costal area beyond the postmedial line and below the cell extending to the medial line; subterminal line white with two small wedge-shaped black marks before it below costa, excurved below costa and at middle, then incurved and slightly waved, and with black marks beyond it above and below vein 2; a terminal series of small black spots defined on inner side by white; cilia wholly white at middle, red-brown at base, with white tips towards apex and dark leaden-grey tips at discal fold and towards tornus and with slight blackish line through them. Hind wing white; the underside with brown spots at middle of costa and apex and postmedial bar from costa.

♀. Dorsum of thorax grey and black; abdomen red-brown; fore wing with more grey suffusion on the white area; hind wing red-brown, the cilia white at tips; the underside white suffused with brown, a brown discoidal bar and postmedial line excurved beyond the cell.

1908: Nov. 19,—1 ♀. 1909: Apr. 6,—1 ♀; Apr. 8,—1 ♂, 1 ♀ (types); Apr. 9,—1 ♀; Apr. 10,—2 ♀; Apr. 14,—1 ♀; May 7,—1 ♀; May 9,—1 ♀.

Also in the British Museum from Br. E. Africa, Athi Valley (*Crawshay*), 1 ♂. *Exp.* 20 millim.

6081 *b.* HOPLOTARACHE CÆRULEOPICTA, sp. n. (Pl. I. fig. 37, ♂.)

♂. Head, thorax, and abdomen ochreous tinged with rufous; pectus, legs, and ventral surface of abdomen ochreous white, the fore and mid tibiae and the tarsi brown ringed with white. Fore wing with the basal half creamy white, the terminal half olive-

brown; subbasal line double, olive-brown, sinuous, from costa to vein 1; antemedial line double, olive-brown; a black point in middle of cell and incomplete black discoidal annulus slightly defined by white; medial line dark, defining the pale area, oblique to lower angle of cell, then incurved; an oblique wedge-shaped postmedial creamy-white patch from costa, then a diffused dark line, strongly incurved and with patches of silvery-blue scales beyond it; subterminal line interrupted in places, cupreous red defined on each side by creamy white, excurved to near termen below vein 7 and at middle, then slightly waved; a terminal series of black striae defined by creamy white; cilia creamy white from vein 4 to submedian fold. Hind wing creamy white, the veins and terminal area tinged with brown; the underside creamy white, the terminal area tinged with brown, a small blackish discoidal spot and faint brownish medial and postmedial bars from costa.

♀. Fore wing with the basal half tinged with red-brown; hind wing cupreous red-brown, the cilia white at tips, the underside creamy white tinged with red-brown, the terminal area suffused with red-brown, a small dark discoidal spot and curved postmedial line.

1909: Apr. 9,—1 ♂; Apr. 15,—1 ♀ (type); Apr. 24,—1 ♂ (type). *Exp.* 22 millim.

6089. *METAPIOPLASTA INSOCIA* Wlk.

1908: May 4,—1 ♂.

6091 *a.* *AULOTARACHE PLUMBEOGRISEA*, sp. n. (Pl. I. fig. 34, ♀.)

♀. Head, thorax, and abdomen reddish ochreous, the patagia suffused with leaden grey; pectus, legs, and ventral surface of abdomen ochreous white, the fore legs tinged with red-brown. Fore wing brownish suffused with leaden grey; some ochreous and rufous on inner margin towards base; traces of a sinuous dark antemedial line from cell to inner margin, faintly defined on inner side by ochreous; claviform a very narrow ochreous mark defined by some black scales; orbicular on outer side and reniform on inner side very faintly defined by black; postmedial line dentate, indistinct and brown from below costa to vein 6, then blackish and defined on outer side by yellow and red patches in the interspaces, oblique below vein 4; a terminal series of minute black points defined on inner side by white points. Hind wing white, the costal and terminal areas tinged with brown. Underside of fore wing and costal area of hind wing suffused with reddish brown.

1908: Sept. 23,—1 ♂; Sept. 25,—1 ♀; Oct. 17,—1 ♀ (type); Oct. 24,—1 ♀. **1909:** Apr. 15,—1 ♀; Apr. 20,—2 ♀; May 9,—1 ♀ (B.M.); May 10,—1 ♀; May 12,—1 ♀. *Exp.* 22–26 millim.

6122. *TARACHE ZELLERI* Wllgrn.

1908: Sept. 18,—1 ♂.

6155. *TARACHE UMBRIGERA* Feld.

1908: May 24,—1 ♂. 1909: Apr. 18,—2 ♀.

6167. *TARACHE OPALINOIDES* Guen.

Mandera.—1908: July 17,—1 ♀. 1909: Apr. 9,—1 ♀;
Apr. 10,—1 ♂; Apr. 27,—1 ♀.

Hargaisa.—1908: Oct.,—1 ♂, 1 ♀.

6175. *TARACHE CARNESEENS* Hmps. n.

1909: Oct. 22,—1 ♀.

6182. *TARACHE HORTENSIS* Swinh.

1908: Aug. 16,—1 ♀; Sept. 28,—1 ♀; Sept. 29,—1 ♂.
1909: Apr. 7,—1 ♀; Apr. 8,—1 ♀; Nov. 24,—1 ♂.

6187 *a.* *TARACHE MESOLEUCA*, sp. n. (Pl. I. fig. 38, ♂.)

♂. Head, thorax, and abdomen white, the dorsum of thorax behind the tegulae with grey mixed. Fore wing pale leaden grey, the basal area with some white mixed; a subbasal white point below costa and streak above base of vein 1; a waved white antemedial line; a white medial band; a black annulus in the cell towards extremity and rather elliptical discoidal annulus; a triangular white patch on postmedial part of costa with the faint diffused red-brown postmedial line arising from it, strongly incurved below vein 4; a very indistinct brownish subterminal line with some white on it at costa, incurved and with white scales on its outer edge below vein 3; a terminal series of black striae defined on inner side by white on inner half; cilia with white mixed from vein 3 to submedian fold. Hind wing white, the costal area and termen, except towards tornus, tinged with brown; the underside white with small brown discoidal spot.

1908: Aug. 15,—1 ♂ (type). *Exp.* 18 millim.

6191 *a.* *TARACHE MIOGONA*, sp. n. (Pl. I. fig. 39, ♀.)

♀. Head grey-brown, the palpi white except at tips; thorax brownish white with fuscous scales mixed; pectus and legs white, the fore and mid tibiae banded with fuscous, the tarsi black ringed with white; abdomen red-brown, the ventral surface white. Fore wing with the basal area brownish white with some red-brown scales towards costa and a grey tinge at base of inner margin, its outer edge rather oblique and diffused; a black point in the cell near base; the rest of wing chocolate-brown tinged with purplish grey; a conical brownish-white postmedial patch on costa with the blackish postmedial line arising from it, incurved below vein 4 to below end of cell and slightly angled outwards at vein 1; subterminal line formed

by brownish-white scales, slightly waved, incurved below vein 3 and ending at tornus; a terminal series of black striæ; cilia with a slight dark line through them. Hind wing pale red-brown, the terminal area darker; cilia fuscous with a white line at base and white tips except towards tornus; the underside with white patch on costa towards apex.

1909: Apr. 10,—1 ♀ (type). *Exp.* 24 millim.

Subfam. EUTELIANÆ.

6258. *EUTELIA DISCISTRIGA* Wlk.

1909: Feb. 27,—1 ♀; Apr. 20,—1 ♀; June 12,—1 ♀.

6258 a. *EUTELIA GRISESCENS*, sp. n. (Pl. I. fig. 40, ♂.)

♂ ♀. Head, thorax, and abdomen grey, the thorax tinged with rufous; palpi with the base of 2nd and 3rd joints brown; tarsi brownish with pale rings; abdomen with some rufous on dorsum, the crests and anal tuft blackish. Fore wing with the basal area rufous defined by the deeper rufous antemedial line, which is angled outwards below costa, then incurved; the rest of wing grey; a faint reddish-brown medial line, bent outwards to the discocellulars and incurved below the cell; postmedial line black with some fuscous beyond it towards costa, oblique and slightly sinuous to vein 6, then almost obsolete and much interrupted, excurved at middle then incurved, some rufous beyond it at discal fold and in submedian interspace; a brownish patch on costal area with two white points at costa before the subterminal line, some yellowish rufous below and beyond it; subterminal line slight, whitish and somewhat waved, incurved below costa and vein 3; a terminal series of black striæ; cilia dark brown, chequered with white at base. Hind wing grey-white, the terminal area tinged with brown and with brownish streaks on the veins; a fine black terminal line; cilia chequered blackish and white; the underside with the costal area and terminal area to vein 2 tinged with rufous, a blackish discoidal point and punctiform postmedial line.

1909: Mar. 13,—1 ♂. 1910: Mar. 14,—1 ♀; Mar. 16,—1 ♂ (type). *Exp.* ♂ 22, ♀ 26 millim.

Subfam. STICTOPTERINÆ.

6458. *STENOSTICTA GRISEA* Hampsh.

1908: Aug. 15,—1 ♂, 2 ♀; Aug. 24,—1 ♀; Sept. 13,—1 ♀; Sept. 21,—1 ♂; Oct. 15,—1 ♂; Oct. 28,—1 ♀. 1909: Feb. 13,—1 ♂; Mar. 14,—1 ♀; Mar. 22,—1 ♂; Mar. 28,—1 ♂.

Subfam. ACONTIANÆ.

6863. *EARIAS INSULANA* Boisd.

1908: Oct. 31,—1 ♂.

6980. *MAURILIA ARCUATA* Wlk.

1908: Oct. 25,—1 ♂.

7068. *NEGETA LUMINOSA* Wlk.

1908: July 11,—1 ♀.

7116. *ACONTIA ALBAGO* F.

1909: Apr. 24,—1 ♀; Apr. 26,—1 ♀.

7117. *ACONTIA GEPHYRIAS* Meyr.

1909: May 8,—1 ♂.

Subfam. CATOCALINÆ.

7353. *ULOTHRICHOPUS TINCTIPENNIS* Hmps. n.

1909: July 6,—1 ♂.

7362. *CHELECALA TREFOLIATA* Butl.

1910: Jan. 10,—2 ♀.

7367. *HYPOTACHA INDECISA* Wlk.

1908: July 24,—1 ♂; Aug. 26,—1 ♀.

7423. *CYLIGRAMMA LATONA* Cram.

1909: May 20,—1 ♀; May 21,—1 ♀; May 23,—1 ♂; May 29,—1 ♂; May 30,—1 ♀; May 31—3 ♂, 2 ♀; June 1,—8 ♂, 6 ♀; June 2,—2 ♀; June 4,—2 ♂; June 5,—1 ♀; June 6,—6 ♂, 4 ♀; June 7,—2 ♂, 1 ♀; June 9,—1 ♂, 8 ♀; June 14,—1 ♂; Sept. 8,—1 ♂. 1910: June 4,—1 ♀.

7493 *a.* *ACANTHONYX SERIOPUNCTA*, sp. n. (Pl. I. fig. 41, ♂.)

♂. Head and thorax ochreous yellow, the tegulæ tinged with rufous; antennæ whitish tinged with rufous; abdomen ochreous white with dorsal rufous segmental lines, the ventral surface ochreous. Fore wing ochreous yellow sparsely irrorated with red-brown scales; subbasal red-brown points below costa and cell; a minute antemedial red-brown spot below costa and points on median nervure and vein 1; an oblique chocolate-brown discoidal bar tinged with grey, rather rounded above; a minute postmedial red-brown spot below costa, then a curved series of points on the veins; fine brownish lines on termen and through the cilia. Hind wing white. Underside white; fore wing with the costal area ochreous, the terminal area tinged with ochreous except towards tornus; hind wing with the costal area and the termen narrowly tinged with ochreous.

Hargaisa.—1908: Oct.,—1 ♂ (type). *Exp.* 40 millim.

7667. *ACHÆA CATELLA* Guen.

Mandera.—1908: Dec. 17,—1 ♀. 1909: Jan. 9,—1 ♂; May 24,—1 ♀; May 25,—2 ♀; June 7,—1 ♂; July 9,—1 ♀.

Durbar.—1908: Dec. 6,—3 ♂.

7747. *PARALLELIA ALGIRA* L.

1909: Apr. 8,—1 ♂.

7764 *a.* *PARALLELIA RECTIFASCIA* Fawcett.

1909: Apr. 22,—1 ♂.

7786. *GRAMMODES STOLIDA* Fabr.

1908: May 4,—1 ♀; Aug. 28,—1 ♂; Sept. 11,—1 ♂; Sept. 12,—1 ♂; Sept. 23,—1 ♂; Sept. 25,—1 ♀; Sept. 30,—2 ♀; Oct. 1,—1 ♂. 1909: Mar. 14,—1 ♂; Apr. 15,—1 ♀; Apr. 24,—1 ♀; May 9,—1 ♂, 4 ♀; May 10,—2 ♂, 5 ♀; May 12,—2 ♀; May 14,—1 ♂; May 21,—1 ♂. 1910: Feb. 9,—1 ♀.

7792. *CHALCIOPE HYPPASIA* Cram.

1908: Nov. 19,—1 ♂.

7855. *MOCIS REPANDA* F.

1909: June 4,—1 ♂.

8075. *CEROCALA ILLUSTRATA* Holl.

Mandera.—1908: Feb. 11,—1 ♀; Apr. 28,—1 ♀; May 28,—1 ♀; June 30,—1 ♀; July 27,—1 ♀; July 31,—1 ♂; Aug. 23,—1 ♂; Aug. 26,—1 ♀; Sept. 22,—1 ♂; Oct. 22,—1 ♂; Nov. 13,—1 ♀; Nov. 25,—1 ♀. 1909: Jan. 9,—2 ♀; Jan. 15,—1 ♀; Jan. 17,—3 ♀; Feb. 14,—2 ♀; Feb. 16,—1 ♀; Feb. 17,—2 ♀; Feb. 21,—1 ♂; Mar. 10,—1 ♀; Mar. 13,—2 ♀; Mar. 17,—3 ♀; Mar. 20,—1 ♂, 1 ♀; Mar. 21,—1 ♀; Mar. 22,—2 ♀; Mar. 24,—1 ♂, 1 ♀; Mar. 26,—4 ♀; Mar. 28,—1 ♀; Mar. 29,—1 ♀; Apr. 7,—1 ♀; Apr. 8,—2 ♂, 2 ♀; Apr. 10,—1 ♂, 2 ♀; Apr. 11,—3 ♂, 1 ♀; Apr. 14,—1 ♂, 1 ♀; Apr. 19,—1 ♀; May 8,—1 ♀; May 10,—1 ♂, 2 ♀; June 9,—1 ♂; Oct. 11,—1 ♂; Nov. 11,—2 ♀; Nov. 12,—2 ♀. 1910: Mar. 14,—1 ♀.

Gan Libbah.—1908: June 24,—1 ♀.

Berbera.—1908: Mar. 4,—2 ♀.

8077 *a.* *CEROCALA ALBIMACULA*, sp. n. (Pl. I. fig. 42, ♂.)

♂. Head, thorax, and abdomen brown mixed with white, the thorax mostly brown, the tegulae dark brown, white at base and tips; antennae ringed black and white; tarsi brown ringed with white; ventral surface of abdomen white. Fore wing whitish almost wholly suffused with grey-brown and reddish brown, leaving a rather quadrate white patch beyond the reniform; antemedial line obsolete on costal area, then double, black, slightly sinuous, with diffused silvery and black scales before it, the outer line slightly defined on outer side by white: orbicular and reniform with silvery and brown centres incompletely defined by black; the former small, round, the latter with dark streak before it in lower part of cell; postmedial line black slightly defined on inner side by whitish, excurved below costa and

between veins 3 and 2 to the subterminal line, then retracted upwards to lower angle of cell, waved to vein 1 and oblique to inner margin, some black and silvery scales beyond it in its sinus; subterminal line whitish defined on inner side by black marks and some silvery scales between veins 7 and 3, angled outwards below vein 7 and excurved at middle; a waved dark terminal line; cilia chequered brown and white. Hind wing white suffused with reddish brown; a dark discoidal spot with some white beyond it; an indistinct dark subterminal shade with dark patches beyond it below apex and at middle with white above them; cilia white chequered with brown. Underside white; fore wing with round black discoidal spot, some brown suffusion from below end of cell and fuscous subterminal and terminal marks towards apex; hind wing with black discoidal spot, some brown suffusion from below end of cell to the sinuous brown postmedial shade, and blackish patches on termen below apex and at middle.

♀. Fore wing with more white, especially at base and on terminal area except at apex.

1908: Sept. 29,—1 ♀ (type); Oct. 11,—1 ♂ (type). **1909**: Apr. 7,—1 ♀; Apr. 20,—1 ♂; Oct. 5,—1 ♀; Oct. 14,—1 ♀. *Exp.* ♂ 28, ♀ 34 millim.

8078. *CEROCALA OPIA* Druce.

1908: Feb. 1,—1 ♂; Feb. 7,—1 ♀; Feb. 11,—1 ♂; Sept. 17,—1 ♀; Sept. 18,—1 ♀; Sept. 21,—3 ♀; Sept. 22,—1 ♀; Sept. 23,—1 ♀; Sept. 27,—1 ♂; Oct. 3,—1 ♀. **1909**: Feb. 23,—1 ♀; Mar. 1,—1 ♀; Mar. 11,—1 ♀; Mar. 14,—1 ♀; Mar. 19,—1 ♀; Mar. 22,—1 ♀; Mar. 26,—1 ♀; Apr. 6,—1 ♀; Apr. 7,—1 ♂; Apr. 8,—1 ♀; Sept.—1 ♂; Oct. 5,—1 ♀; Nov. 6,—1 ♀. **1910**: Jan. 5,—1 ♀.

8092. *GNAMPTONYX INNEXA* Wlk.

Mandera.—**1908**: July 17,—1 ♀; Sept. 19,—1 ♀. **1909**: Mar. 14,—1 ♂, 1 ♀; Mar. 28,—1 ♀; Mar. 29,—2 ♀; Apr. 8,—1 ♀. **1910**: Mar. 14,—1 ♀; Mar. 20,—1 ♀.

Hargaisa.—**1908**: Oct.—1 ♀.

8117. *PERICYMA METALEUCA* Hmps.

1908: Aug. 24,—1 ♂. **1909**: May 10,—1 ♀.

8125. *CORTYTA LEUCOPTERA* Hmps.

The series, besides the typical form, includes specimens agreeing with *C. dispar* Püng., *C. fasciolata* Warr., *C. balnearia* Dist., *C. impar* Hmps., and *C. eremochroa* Hmps., which are evidently forms of one variable species; they also occur together in the Hoggar Mts., S. Sahara, *vide* Rothschild, A. M. N. H. (8) xvi. p. 255 (1915).—G. F. H.

1903: Mar. 22,—1 ♂; July 8,—2 ♀; Aug. 20,—1 ♀ (B.M.); Sept. 16,—1 ♂; Sept. 19,—1 ♂, 1 ♀; Oct. 29,—1 ♂ (B.M.).

1909: Feb. 17,—1 ♀ (B.M.); Mar. 11,—1 ♀ (B.M.); Apr. 7,—1 ♀; Apr. 10,—1 ♀ (B.M.); Sept. 21,—1 ♂ (B.M.), 1 ♀; Sept.,—4 ♂; Oct. 14,—2 ♂ (1 in B.M.), 1 ♀; Oct. 22,—1 ♂; Dec. 28,—1 ♂. **1910:** Feb. 10,—1 ♀; Mar. 20,—1 ♂.

8132. *CORTYTA ROSACEA* Rebel.

1908: July 17,—1 ♀; Oct. 2,—1 ♀; Nov. 25,—1 ♂ (B.M.).
1909: Mar. 14,—1 ♂; May 10,—1 ♀; Oct. 14,—1 ♀.

8135. *CORTYTA CANESCENS* Wlk.

Mandera.—**1909:** Apr. 14,—1 ♂.

Hargaisa.—**1908:** Oct.,—1 ♀.

Subfam. PHYTOMETRINÆ.

8292. *PHYTOMETRA NI* Hübner.

1908: Oct. 1,—1 ♀. **1909:** Apr. 6,—1 ♀; Sept.,—1 ♀.

8295. *PHYTOMETRA LIMBIRENA* Guen.

Hargaisa.—**1908:** Oct.,—1 ♂.

8330. *PHYTOMETRA ACUTA* Wlk.

1909: Mar. 30,—1 ♀; Apr. 6,—1 ♂; Apr. 29,—1 ♀; May 3,—1 ♂; May 21,—1 ♂.

Subfam. NOCTUINÆ.

PANDESMA ANYSA Guen.

1909: Apr. 6,—1 ♂.

POLYDESMIA COLUTRIX Geyer.

1908: June 18,—3 ♀; July 2,—1 ♀; July 5,—2 ♂ (1 in B.M.); July 25,—1 ♀; July 26,—1 ♀; Aug. 1,—1 ♀. **1909:** July 13,—1 ♀.

PROCONIS ABROSTOLOIDES Hampson.

1909: Sept. 17,—1 ♀; Sept.,—1 ♀; Oct. 11,—1 ♀ (B.M.).
1910: Feb. 10,—1 ♀.

AUTHADISTIS CAMPTOGRAMMA, sp. n. (Pl. I. fig. 44, ♂.)

Antennæ of male with fasciculate cilia.

♂ ♀. Head and thorax pale red-brown mixed with blackish and some whitish; palpi with some black towards base; pectus whitish; fore tibiæ with a black band, the tarsi black ringed with white; abdomen white tinged with reddish brown. Fore wing pale red-brown mixed with some whitish and irrorated with dark brown; subbasal line black, excurved below costa and ending at submedian fold; antemedial line black, oblique towards costa, then erect and very slightly angled inwards at submedian fold; a double sinuous blackish medial line, oblique to discal fold, then

erect; a curved black discoidal striga; postmedial line black, strongly bent outwards below costa, then excurved to vein 3 with a slight inward curve at discal fold, at vein 3 retracted with a downward curve to lower angle of cell, then erect and sinuous, some slight blackish marks beyond it on costa; subterminal line blackish, slightly waved and interrupted, somewhat angled outwards below veins 7 and 4, then incurved; a waved blackish terminal line. Hind wing pure white. Underside white, the costa of both wings slightly irrorated with brown; fore wing with some black points on terminal part of costa, a minutely waved black terminal line, the cilia brown at tips; hind wing with minutely waved black terminal line from apex to vein 2.

Ab. 1. Fore wing with the postmedial line not retracted to lower angle of cell, but curved downwards between veins 3 and 2, then erect.

1908: Sept. 3,—1 ♀; Sept. 17,—1 ♀; Sept. 18,—1 ♀ ab. 1 (B.M.); Sept. 19,—1 ♀; Sept. 23,—1 ♂; Sept. 24,—1 ♀; Oct. 2,—1 ♀; Oct. 3,—1 ♂ (type); Oct. 24,—2 ♂ (1 in B.M.). 1909: Mar. 10,—1 ♀ (B.M.); Mar. 17,—1 ♀; Mar. 29,—1 ♀; Apr. 8,—1 ♀. *Exp.* 22 millim.

AUCHENISA CERURODES, sp. n. (Pl. I. fig. 43, ♂.)

♂. Head and thorax white mixed with some rufous and black; antennæ rufous; palpi black towards base; tarsi black; abdomen white, dorsally mixed with rufous and black. Fore wing white slightly irrorated with fuscous brown; black streaks on vein 1 and inner margin to near middle; an antemedial black patch on costa with slight sinuous line from its outer edge to submedian fold; an oblique blackish shade just beyond the cell between veins 6 and 2; a blackish discoidal spot defined at sides by white; postmedial line double, the outer line black, the inner line black at costa, then slight brown and minutely waved, curved, from costa to vein 2, an oblique wedge-shaped black-brown patch beyond it on costal area; traces of an oblique slightly waved brownish subterminal line; a terminal series of black striæ. Hind wing semihyaline white, a black discoidal lunule and terminal series of small black spots, minute towards apex. Underside white; both wings with black discoidal spots and terminal series of striæ; fore wing with the costa suffused with brown expanding towards apex and with white postmedial mark on it.

1909: Oct. 22,—3 ♂ (including type). *Exp.* 32 millim.

CATEPHIA PYRAMIDALIS, sp. n. (Pl. I. fig. 45, ♂.)

♂ ♀. Head and thorax brown mixed with grey-white; palpi white in front; pectus white; tarsi black ringed with white; abdomen whitish, dorsally suffused with brown, the crests blackish. Fore wing grey suffused and irrorated with dark brown; subbasal line black, sinuous, from costa to vein 1; antemedial line black, waved; claviform defined by black; orbicular defined by black

and with blackish point in centre, round; reniform with blackish centre defined on inner side by white and black lines and on outer side by white, narrow and somewhat produced at lower extremity; medial line blackish, oblique to the reniform, oblique and sinuous below the cell; a triangular whitish shade from post-medial part of costa to beyond the reniform; postmedial line black, strongly bent outwards below costa, then excurved with a curve inwards at discal fold, oblique and sinuous below vein 4, a sinuous dark line beyond it, and some white points on costa; subterminal line dark brown, waved, angled outwards at vein 7 and excurved at middle, then incurved; the veins of terminal area with slight dark streaks; a terminal series of small black lunules. Hind wing white, the veins and inner area tinged with brown, the terminal area broadly fuscous brown; cilia white, tinged with brown at apex, middle, and tornus. Underside white, the costal areas irrorated with brown, the terminal area suffused with brown; both wings with blackish discoidal lunules and postmedial line, excurved below costa of fore wing.

Ab. 1. Fore wing with the postmedial triangular patch whiter and more distinct.

Ab. 2. Fore wing with black-brown fascia above vein 1 between the ante- and postmedial lines.

1908: Sept. 21,—1 ♀; Oct. 30,—1 ♀. **1909:** Mar. 9,—1 ♀ ab. 2 (B.M.); Mar. 13,—1 ♀; Mar. 26,—1 ♂; Mar. 30,—1 ♀; Apr. 6,—1 ♀; Apr. 8,—1 ♂, 1 ♀ (♂ is ab. 2, in B.M.); Apr. 10,—1 ♀; Apr. 11,—2 ♀; Apr. 15,—1 ♀; Apr. 18,—1 ♀; Oct. 14,—1 ♂, 1 ♀ (♂, type, B.M.); Oct. 22,—1 ♀; Nov. 6,—1 ♀ (B.M.); Nov. 7,—1 ♀, ab. 1 (B.M.). **1910:** Mar. 6,—1 ♀; Mar. 16,—2 ♀ (1 ab. 1 in B.M.). *Exp.* 24–30 millim.

CATEPHIA POLIOCHROA, sp. n. (Pl. I. fig. 47, ♀.)

♀. Head, thorax, and abdomen white mixed with brown; frons with lateral black bars; pectus white; legs white tinged with rufous. Fore wing whitish suffused with brownish grey; subbasal line black, from costa to submedian fold; antemedial line black, oblique and sinuous to submedian fold, then angled inwards at vein 1, a slight oblique black streak before it above inner margin; claviform red-brown defined by black and with black streak from it to the postmedial line, oblique, with its upper edge extending to median nervure; orbicular and reniform defined by blackish except above, rather elliptical, the latter with some fuscous in its lower part; an oblique blackish shade from costa to the reniform, and waved line from submedian fold to inner margin; postmedial line black, strongly bent outwards below costa, incurved at discal fold, angled outwards at veins 4, 3, then incurved and sinuous; a faint waved whitish subterminal line with slight blackish streaks before it in the interspaces; a fine waved black terminal line; cilia brown with a whitish line at base. Hind wing white, the terminal area fuscous brown, the inner area tinged with brown; cilia white, the tips brownish

at middle. Underside white, the costal and terminal areas irrorated with brown; both wings with brown discoidal spot and subterminal shade.

1909: May 12,—1 ♀ (type). *Exp.* 40 millim.

CATEPHIA PERICYMA, sp. n. (Pl. I. fig. 46, ♂.)

♂. Head and thorax pale grey mixed with brown, the tegulae with elliptical black-defined annuli; frons with lateral black bars; tarsi black ringed with white; abdomen brown mixed with whitish, the ventral surface whitish. Fore wing pale grey thickly irrorated with brown and black, the veins beyond the cell with slight dark streaks; a black-brown fascia below base of submedian fold; antemedial line black, excurved below the costa and cell, incurved in the cell and below submedian fold, an oblique black-brown shade before it on inner area, and a shade beyond it in submedian interspace to the postmedial line, filling in the claviform, which is large, defined by black, extending to the cell and acute at extremity; orbicular and reniform large, defined by black, the former round, the latter elliptical; a slight oblique brown shade from middle of costa extending into the reniform; postmedial line black, strongly bent outwards below costa, then oblique to vein 6, oblique from vein 5 to below 4, then strongly incurved, dark brown streaks beyond it on veins 3 and 2, and a black streak just below vein 2 with a slight white mark below it beyond the postmedial line; a waved black terminal line. Hind wing white, the inner area tinged with red-brown, the terminal area dark cupreous brown, broad at costa, narrowing to tornus, its inner edge sinuous; cilia white, with brown line through them between veins 4 and 2. Underside white; fore wing with the costa slightly tinged with purple, a brown discoidal spot, a subterminal brown shade except towards costa and inner margin, the area beyond it irrorated with purplish; hind wing with the costa slightly irrorated with purplish, a brown subterminal shade except towards tornus with some brown and purplish irroration beyond it.

♀. Abdomen whiter; fore wing with the brown shade on basal and median areas more diffused to inner margin, and with slight brown shade before the postmedial line except towards costa.

1909: Mar. 14,—1 ♂, 1 ♀ (types). *Exp.* ♂ 34, ♀ 40 millim.

CATEPHIA MESONEPHELE, sp. n. (Pl. I. fig. 48, ♂.)

♂. Head and thorax whitish mixed with dark brown, the tegulae except at tips tinged with rufous; frons with black lateral bars; palpi with some dark brown at sides of 2nd and 3rd joints; pectus white; legs tinged with rufous, the tarsi dark brown ringed with white; abdomen white, dorsally suffused with brown, the crests dark brown. Fore wing grey-white tinged with brown, the basal area suffused in parts with dark brown; subbasal line black, sinuous, from costa to submedian fold; antemedial line

black defined on inner side by white, excurved below costa and at middle and more strongly to inner margin, where there is an oblique black bar before it; the medial area with oblique bright red-brown fascia from median nervure through the claviform to the postmedial line at inner margin; claviform defined by black, extending to median nervure, oblique and acute at extremity; orbicular and reniform with white annuli rather incompletely defined by brown, the former with brownish centre, round, the latter with its centre faintly defined by brown and with small brown spot in lower part, large, elliptical; postmedial line black, slightly bent outwards below costa then slightly sinuous, rather oblique to vein 4 then incurved, a faint brown line beyond it to vein 4; an oblique red-brown shade from apex and faint postmedial line, angled outwards at vein 3; a waved black terminal line forming points at the interspaces; a fine white line at base of cilia. Hind wing pure white, the terminal area fuscous brown from apex to vein 2. Underside of fore wing white, the terminal area broadly suffused with fuscous.

1908: Oct. 3,—1 ♂ (type). *Exp.* 24 millim.

CATEPHIA EURYMELAS, sp. n. (Pl. I. fig. 49, ♂.)

♂ ♀. Head and thorax grey-white mixed with brown, the tegulae with black lines; frons with lateral black bars; palpi white with some black at sides of 2nd and 3rd joints; pectus white; legs white tinged with rufous, the tarsi rufous ringed with white; abdomen rufous, the crests blackish, the ventral surface white. Fore wing grey suffused in parts with reddish brown, an oblique whitish shade from costa towards apex to end of cell; a subbasal black striga from costa and oblique streak above vein 1; antemedial line double, the outer line black, the inner indistinct, waved, angled inwards above inner margin; claviform slightly defined by black, narrow; orbicular and reniform defined by black, the former round, the latter incompletely defined on outer side and with blackish mark in lower part; postmedial line blackish, bent outwards below costa, then sinuous, oblique to vein 3, then incurved, some white points beyond it on costa; subterminal line reddish brown, diffused on inner side, oblique, excurved below vein 7 and at middle; a terminal series of black points. Hind wing white, the terminal area broadly black-brown from apex to submedian fold, then narrowly black-brown, the inner margin tinged with brown; cilia white with some black-brown at veins 2 and 1. Underside white, the terminal areas of both wings broadly blackish to submedian fold leaving some whitish on costa and termen of fore wing and at apex of hind wing.

Ab. 1. Patagia and basal half of fore wing strongly suffused with black-brown, the latter with the terminal half whiter slightly tinged with brown and with blackish marks at apex, at discal fold beyond the postmedial line and at termen and between terminal parts of veins 3 and 2.

1908: Sept. 25,—1 ♀. **1909:** Mar. 14,—2 ♀; Mar. 15,—1 ♀; Mar. 20,—1 ♀; Apr. 8,—1 ♂ (type), 1 ♀ (B.M.); Nov. 6,—1 ♀, ab. 1 (B.M.). *Exp.* 22–26 millim.

LYNCESTIS DIASCOTA, sp. n. (Pl. I. fig. 50, ♂.)

♂. Head, thorax, and abdomen white mixed with some grey; the tegulae with black band near tips, the abdomen dorsally suffused with fuscous from near base to beyond middle; tarsi black ringed with white. Fore wing white slightly tinged with grey, a broad oblique fuscous grey shade from costa towards apex to inner margin beyond middle, a slight black streak below basal half of costa, and the veins of terminal area streaked with black; the basal area with grey shades along median nervure and vein 1; a slight oblique dark antemedial line from cell to inner margin; a slight black streak in end of cell; cilia tinged with brown. Hind wing white, the veins towards termen streaked with black, the apex tinged with brown; a blackish terminal line. Underside of fore wing suffused with reddish brown; hind wing with the costal area irrorated with reddish brown, a subterminal shade from costa to vein 2.

♀. Greyer; hind wing with the terminal area broadly suffused with black.

1908: Sept. 16,—1 ♂ (type); Sept. 26,—1 ♂. **1909:** Mar. 19,—1 ♂; Sept. 20,—1 ♀ (type). *Exp.* 28 millim.

LYNCESTIS AMPHIX Cram.

Year?: Mar. 20,—1 ♂.

SPHINGOMORPHA CHLOREA Cram.

Mandera.—**1908:** Nov. 17,—1 ♂. **1909:** Mar. 28,—1 ♀; Apr. 5,—1 ♂; June 6,—1 ♂, 2 ♀. **1910:** Feb. 9,—1 ♀.

Gan Libbah.—**1908:** June 24,—1 ♂; June 26,—1 ♀.

Hargaisa.—**1909:** Nov.,—1 ♂.

PASIPEDA SAMBESITA Wlk.

1909: Apr. 24,—1 ♂; May 21,—1 ♀; July 6,—1 ♂.

OGLASA CORNUTA Hmps.

1908: Nov. 17,—1 ♀. **1909:** Mar. 14,—1 ♀; Mar. 28,—1 ♂.

ASPLENIA RUBRESCENS, sp. n. (Pl. II. fig. 1, ♂.)

♂ ♀. Head and thorax red-brown mixed with some whitish and a few dark brown scales; pectus and legs whitish, the fore tarsi ringed with fuscous; abdomen red-brown, the ventral surface whitish. Fore wing bright rufous with slight dark irroration, a whitish shade tinged with rufous just beyond the cell; slight sub-basal blackish points on costa and in the cell; antemedial line black, waved, double at costa; a small black annulus filled in with white in the cell towards extremity, and a slight discoidal lunule

defined by blackish; a diffused blackish medial line, excurved beyond the cell, then incurved and slightly waved; postmedial line indistinctly double, red-brown and blackish filled in with whitish, slightly bent outwards below costa, then slightly waved and produced to black and white points on the veins, excurved to vein 4, then incurved, some pale points beyond it on costa; subterminal line whitish defined on inner side by dentate black marks in the interspaces, excurved below vein 7 and at middle; a terminal series of black striæ; cilia with some white at tips. Hind wing pale red-brown with a dark subterminal shade; some dark suffusion on termen towards apex and a dark terminal line; cilia white at tips; the underside white tinged with rufous, a dark discoidal point, curved red-brown postmedial line with dark points on the veins and slight subterminal shade.

1909: Mar. 26,—1 ♂; Apr. 7,—1 ♀; Apr. 8,—1 ♂; Apr. 9,—1 ♂; Apr. 10,—1 ♀; Apr. 11,—1 ♀ (B.M.); Apr. 15,—1 ♂; Apr. 20,—1 ♀; Apr. 22,—1 ♂; Apr. 23,—1 ♀; May 7,—1 ♂ (B.M.); 1 ♀; May 10,—1 ♂, 1 ♀; May 12,—1 ♂ (type); May 21,—1 ♀. *Exp.* 24–28 millim.

TEPHRIAS TRIGONOSEMA, sp. n. (Pl. II. fig. 2, ♀.)

♀. Head and tegulæ yellow tinged with rufous, the tegulæ with a rufous band behind them; thorax creamy white; antennæ red-brown; legs slightly tinged with brown; abdomen whitish, dorsally tinged with brown. Fore wing creamy white slightly irrorated with red-brown, the costa red-brown to beyond middle; a conical antemedial chocolate-brown patch from just above median nervure, its base extending to the scale-tooth on inner margin and outwardly resting on vein 1; faint oblique rufous antemedial and medial striæ from costa; postmedial line chocolate-brown, arising below costa, straight to vein 4, then retracted upwards to upper angle of cell, then running downwards with a slight inwards curve to submedian fold just beyond the antemedial patch, and with a triangular chocolate-brown patch below it between vein 4 and submedian fold; the area beyond the postmedial line and below the outer part of the antemedial patch suffused with red-brown shading to ochreous at termen; subterminal line indistinct, dark brown, oblique, dentate, angled outwards below veins 7 and 4. Hind wing creamy white suffused with red-brown especially towards termen; the underside creamy white irrorated with red-brown, the apical part of terminal area suffused with brown, a slight discoidal spot and faint curved postmedial line.

1908; Apr. 27,—1 ♀ (type). *Exp.* 22 millim.

PLECOPTERA POLYMORPHA, sp. n. (Pl. II. fig. 3, ♂.)

♂. Head and thorax brownish white slightly irrorated with fuscous; antennæ brownish; pectus and abdomen white. Fore wing white, tinged in parts with pale red-brown and irrorated

with black scales; a slight red-brown subbasal line from costa to submedian fold; antemedial line red-brown, sinuous; two small almost conjoined black discoidal spots; postmedial line red-brown with some diffused blackish at costa, straight and almost erect to vein 4, then slightly incurved, a series of black points beyond it from costa to vein 4; traces of a whitish subterminal line, excurved below vein 7 and at middle; the termen and cilia suffused with red-brown; a fine waved red brown terminal line with minute dark points at the interspaces. Hind wing white tinged with red-brown and irrorated with black, the termen and cilia more strongly tinged with red-brown; a red-brown postmedial line, excurved beyond lower angle of cell; a waved red-brown terminal line. Underside white faintly tinged with brown and irrorated with a few black scales; hind wing with black bar on upper discocellular.

♀. Varying from whitish tinged with rufous to purplish grey suffused with reddish brown, the lines of both wings and discoidal spots of fore wing often indistinct.

Ab. 1. Both wings with strong red-brown shade before the postmedial line which is defined on outer side by white.

1903: Sept. 12,—2 ♀ (1 ab. 1 in B.M.); Sept. 22,—1 ♀; Sept. 24,—1 ♂ (type). 1909: Mar. 14,—1 ♀; Apr. 18,—1 ♀; Apr. 24,—1 ♀ (B.M.); Apr. 26,—1 ♀ (B.M.); Apr. 27,—1 ♀; Sept.—2 ♂; Oct. 4,—1 ♀; Nov. 12,—1 ♀ (type).

Also in B.M. from Abyssinia, Tamasso (*Degen*), 1 ♀. *Exp.* 30-32 millim.

PLECOPTERA HYPOXANTHA Hmps.

1909: July 6,—2 ♀.

ACANTHOLIPES CIRCUMDATA Wlk.

1909: Oct. 8,—1 ♀.

ACANTHOLIPES TRIMENI Feld.

1909: May 12,—1 ♀.

ANTARCHÆA SUBFLAVALIS Wlk.

1903: Oct. 25,—1 ♂.

ANTARCHÆA FRAGILIS Butl.

1908: Sept. 14,—1 ♀; Nov. 13,—1 ♀. 1909: Oct. 14,—1 ♀.

TATHORHYNCHUS EXSICCATA Led.

1909: May 10,—1 ♂.

AXOMIS FIMBRIAGO Steph., or EROSA Hübner.

1909: Apr. 6,—1 ♀. The females of *fimbriago* and *erosa* cannot be distinguished with certainty.

CALPE VAGABUNDA Swinh.

Mandera.—1908: May 29,—1 ♀; Sept. 16,—1 ♀. 1909: Mar. 12,—1 ♂; Apr. 15,—1 ♀; Sept. 9,—1 ♀.

Hargaisa.—1908: Oct.,—1 ♂ (B.M.).

ARGADESA MATERNA L.

1909: Apr. 6,—1 ♂, 1 ♀; May 21,—1 ♂.

OPHIDERES FULLONICA L.

Hargaisa.—1909: July,—1 ♂, 1 ♀.

This species and the last were often seen at light, but were not sufficiently attracted to be easily captured.

Subfam. HYPENINÆ.

SARMATIA INTERITALIS Guen.

1908: Sept. 26,—1 ♂. 1909: Apr. 22,—1 ♀; May 10,—1 ♀.

SIMPLICIA CAPALIS Wlk.

1908: June 1,—1 ♀.

NODARIA EXTERNALIS F.

1908: June 2,—1 ♂. 1909: Jan. 16,—1 ♂.

HYPENA STRIGATA F. (*ABYSSINIALIS* Guen.).

1909: Apr. 6,—1 ♂; May 21,—1 ♂; July 6,—1 ♂.

HYPENA JUSSALIS Wlk.

1909: May 26,—1 ♀. 1910: Mar. 16,—1 ♀.

HYPENA MASURIALIS Guen.

1909: Apr. 6,—1 ♀; Nov. 10,—1 ♀.

RHYNCHINA ANTIQUALIS Hübner.

1909: Oct. 22,—1 ♀.

RHYNCHINA PERANGULATA, sp. n. (Pl. II. fig. 7, ♀.)

♂ ♀. Head, thorax, and abdomen grey-white mixed with reddish brown; palpi tinged with red-brown and irrorated with black; ventral surface of abdomen white irrorated with brown. Fore wing grey tinged with red-brown and irrorated with black; ante-medial line white, very oblique from costa to submedian fold, where there is a small fan of raised scales below its extremity; an elliptical red-brown spot in end of cell with white streak below it on median nervure and small white patch beyond its lower extremity; postmedial line fine, blackish, defined on inner side by white and on outer side also towards costa, very oblique to discal fold where it is acutely angled, then oblique to inner margin below the antemedial line, some white points beyond it on costa and an oblique white shade from apex to its angle; a slight

dentate white subterminal line with oblique chocolate-brown shade beyond it from just below apex, then a series of dentate chocolate-brown marks on its outer edge; a fine chocolate-brown terminal line and white line at base of cilia. Hind wing reddish brown; a fine dark terminal line; cilia paler; the underside whitish tinged and irrorated with brown, a brown discoidal point and curved postmedial line.

1909: Apr. 7,—1 ♀ (type).

Also in B.M. from Br. E. Africa, Taveta (*Rogers*), 2 ♂; Mosambique, 1 ♂; Transvaal, Kranspruit (*Janse*), 1 ♀. *Exp.* 20–26 millim.

RHYNCHINA REVOLUTALIS Zell.

1908: Aug. 24,—1 ♀.

RHYNCHINA ALBISCRIPTA, sp. n. (Pl. II. fig. 8, ♂.)

Antennæ of male minutely serrate, with fasciculate cilia.

♂. Head and thorax white irrorated with brown; palpi with the 2nd joint fuscous brown except below, the 3rd with fuscous band; abdomen white, dorsally tinged with brown. Fore wing white suffused with brown, the inner area to the postmedial line and the termen whiter; antemedial line dark brown defined on each side by white, oblique to submedian fold, then inwardly oblique; a minute blackish annulus in the cell towards extremity; a slight white discoidal lunule defined by dark brown; postmedial line black-brown defined on each side by white, oblique to vein 6 and below vein 4; some white points beyond it on costa; a subterminal series of minute white spots in the interspaces, defined on inner side by slight somewhat dentate black marks with dentate white marks before them towards costa; a fine blackish terminal line; cilia with white lines at base and near tips. Hind wing white tinged with reddish brown; a fine brown terminal line; cilia white at tips; the underside white, the costal area and terminal area to vein 3 irrorated with red-brown, a faint curved postmedial line.

1908: Sept. 19,—1 ♂ (type); Oct. 1,—1 ♂.

Also in B.M. from Sudan, Port Sudan (*Mrs. Waterfield*), 3 ♂. *Exp.* 20 millim.

RHYNCHINA ENDOLEUCA, sp. n. (Pl. II. fig. 6, ♂.)

Antennæ of male bipectinate with short fasciculate branches, the apical part ciliated.

♂. Head, thorax, and abdomen grey-white tinged with brown; the crest at base of abdomen fuscous. Fore wing grey-white tinged with brown; a slight white streak in basal half of submedian fold, the area below it paler and tinged with red-brown; antemedial line represented by a striga of raised blackish scales from costa, some black scales on inner area and a small spot further from the base below the cell; a point of raised black scales in the cell towards extremity and a bar from origin of

vein 2 to inner margin with a slight rufous line before it; a slight brown line from above end of cell to vein 6, dentate at veins 7 and 6; some minute blackish streaks on costa towards apex and an oblique whitish shade from apex to end of cell with a rufous tinge on its outer side and short black streaks in the interspaces, ending in an oblique black bar above vein 2 just beyond the bar below the cell; a subterminal series of minute black striae, oblique from below vein 3 to submedian fold, then erect, with a slight streak beyond it in submedian fold; a slight sinuous blackish terminal line and fine white line at base of cilia which are intersected with black at the veins. Hind wing whitish tinged with red-brown; a fine brown terminal line; cilia whiter, slightly intersected with brown at the veins; the underside white tinged with rufous and irrorated with brown except on basal and inner areas, a brown discoidal point, traces of a postmedial line from costa to discal fold and a punctiform black terminal line.

♀. Fore wing with the basal half suffused with fuscous brown to submedian fold in which the white streak is stronger and the inner area more contrasting, the white shade from apex more prominent.

Ab. 1 much darker.

1903: Sept. 20,—1 ♀ (type); Sept. 27,—1 ♂ (type).

Also in B.M. from Sudan, Port Sudan (*Mrs. Waterfield*), 1 ♂, 1 ♀; Br. E. Africa, Sabaki R. (*Gregory*), 1 ♀; Kitu (*Crawshay*), 1 ♀; Takaunga (*F. Thomas*), 1 ♀; Munisu (*Lord Delamere*), 1 ♀. *Exp.* ♂ 20, ♀ 24 millim.

MAGULABA GRISEA, sp. n. (Pl. II. fig. 4, ♂.)

♂ ♀. Head and thorax black-brown mixed with reddish brown; pectus, legs, and abdomen grey, irrorated with dark brown, the palpi and fore legs suffused with black, the tarsi ringed with whitish. Fore wing grey-white suffused with reddish brown and irrorated with blackish; a sinuous blackish antemedial line; a white point in middle of cell and slight whitish discoidal striga placed on a sinuous blackish medial shade, incurved below the cell; an indistinct blackish postmedial line, excurved below costa and at middle, incurved at discal fold and below vein 4; a brown subterminal shade with series of more or less prominent black marks on it, excurved below vein 7 and at middle; a terminal series of black points. Hind wing grey suffused with brown and irrorated with dark brown; traces of two postmedial lines with the area between them rather paler; a terminal series of fuscous striae; the underside white irrorated with brown, a dark discoidal striga and rather diffused brown postmedial and subterminal lines.

1903: Feb. 24,—1 ♂ (B.M.); Sept. 13,—1 ♂; Sept. 22,—1 ♂; Oct. 3,—1 ♂; Oct. 29,—1 ♂; Nov. 13,—1 ♂ (type). **1909:** Apr. 20,—1 ♂; Apr. 22,—1 ♀ (B.M.).

Also in B.M. from S. Nigeria, Sapele (*Sampson*), 1 ♂. *Exp.* 22 millim.

NAARDA NIGRIPALPIS, sp. n. (Pl. II. fig. 5, ♂.)

♂. Head and thorax brown mixed with grey; antennæ blackish slightly ringed with grey; palpi blackish; fore legs black, the tarsi slightly ringed with white; abdomen grey suffused with brown. Fore wing grey thickly irrorated with brown; antemedial line dark brown and sinuous; a minute ochreous spot in middle of cell and ochreous discoidal bar defined at sides by dark brown; a rather diffused erect brown medial line; postmedial line dark brown, sinuous, slightly incurved below vein 4; subterminal line whitish defined on inner side by brown, slightly sinuous; a terminal series of dark brown striæ. Hind wing grey suffused with brown; a slight brown discoidal bar and some dark scales at middle of inner margin; a curved waved brown postmedial line; a rather diffused waved subterminal line; a terminal series of dark brown striæ; the underside whitish irrorated with brown, the discoidal bar and postmedial and subterminal lines more distinct.

1908: Oct. 25,—1 ♂ (type). *Exp.* 18 millim.

Fam. LYMANTRIDÆ.

EUPROCTIS FASCIATA Wlk.

1909: Mar. 14,—1 ♂. **1910**: Mar. 10,—1 ♂.

LÆLIA TESTACEA Wlk.

Mandera.—**1909**: Oct. 6,—1 ♀.

Hargaisa.—**1908**: Oct.,—2 ♂.

CASAMA VILIS Wlk.

1908: May 2,—1 ♂, 1 ♀; May 4,—1 ♂, 1 ♀; Aug. 15,—1 ♂, 1 ♀; Aug. 24,—1 ♂; Aug. 25,—1 ♀; Aug. 26,—1 ♂, 1 ♀; Sept. 3, 1 ♂; Sept. 15,—1 ♂; Sept. 18,—2 ♀; Sept. 19,—1 ♀; Sept. 21,—1 ♂, 1 ♀; Sept. 22,—1 ♂, 1 ♀; Oct. 3,—1 ♀; Oct. 14,—1 ♂; Oct. 15,—1 ♀. **1909**: Jan. 13,—1 ♀; Jan. 18,—1 ♀; Feb. 17,—1 ♂; Feb. 25,—1 ♀; Mar. 12,—1 ♂; Mar. 13,—1 ♀; Mar. 19,—1 ♀; Mar. 24,—1 ♂; Apr. 6,—1 ♂; Apr. 7,—3 ♂; Apr. 8,—1 ♂; Apr. 11,—1 ♀; Apr. 14,—1 ♂; Apr. 24,—1 ♂; Apr. 26,—1 ♂; Apr. 30,—1 ♂; Aug. 17,—1 ♂; Oct. 5,—1 ♂; Oct. 7,—1 ♂; Nov. 25,—1 ♀. **1910**: Jan. 8,—1 ♂.

DASYCHIRA MISERATA Holl.

1903: Aug. 26,—1 ♂.

DASYCHIRA REMOTA Druce.

Year?: Mar. 24,—1 ♀.

ACLONOPHLEBIA INCONSPICUA, sp. n. (Pl. II. fig. 9, ♂.)

♂. Head, thorax, and abdomen dark red-brown mixed with some whitish. Fore wing whitish tinged with red-brown and thickly irrorated with dark brown, the veins with dark streaks;

a dark brown subbasal patch from costa to below the cell; ante-medial line blackish, excurved from below costa to submedian fold where it is slightly angled inwards; traces of a sinuous dark medial line; a curved black discoidal striga; postmedial line blackish slightly defined on outer side by white, somewhat dentate and produced to slight streaks at veins 7 to 2, bent outwards between veins 5 and 3, retracted below vein 2, and slightly angled outwards at submedian fold and vein 1; some slight whitish marks on costa towards apex; cilia brown, intersected with white at veins 7 to 2. Hind wing white, somewhat semihyaline, the veins slightly tinged with brown; the cilia with slight brown spots from apex to vein 2. Underside of fore wing with the terminal area white with a subterminal brown shade rather diffused on inner side and dentate on outer between veins 7 and 3.

Hargaisa.—1908: Oct.,—2 ♂ (including type). *Exp.* 30 millim.

Fam. SPHINGIDÆ.

By DR. KARL JORDAN.

HERSE CONVOLVULI L.

Sphinx convolvuli Linné, Syst. Nat. ed. 10, p. 490. n. 6 (1758).

1909: July 6,—1 ♀; Nov. 6,—1 ♂.

POLIANA MICRA R. & J. (1903).

Poliana micra Rothschild & Jordan, Nov. Zool. ix. Suppl. p. 809, no. 766, text-fig. 6 (1903: Somaliland).

These two males from Manderia are in a better state of preservation than the type, and therefore appear purer grey on the fore wing. The only difference I notice is in the ante- and postmedial double lines being less filled-in with fuscous and a little further apart below the apex of the cell than in the type specimen, the only example hitherto known to us of this species. The genitalia of one of Mr. Feather's specimens have been examined; they are identical with those of the type.

1908: Oct. 31,—1 ♂. 1909: May 13,—1 ♂.

HIPPOTION CELERIO L.

Sphinx celerio Linné, Syst. Nat. ed. 10, p. 491. n. 10 (1758).

Manderia.—1909: Apr. 5,—1 ♂.

Berbera.—1908: Dec. 2,—1 ♀.

HIPPOTION ROSEIPENNIS SOMALICUM, subsp. n.

♂ ♀. Ab *H. ros. roseipenni* ala antica in disco lineis quinque fuscis notata distinguendum.

In true *roseipennis* Butl. (1882), which is known to us from Delagoa Bay northward to British East Africa and Unyoro, the fore wing bears two distinct lines in the outer half, the proximal

line crossing the fuscous patch which is placed at the apex of the cell, and the outer line being nearly continuous with the oblique apical streak. In between these two lines there are at most faint traces of two or three other lines parallel with them. In *somalicum*, on the other hand, the three additional lines are quite distinct, the first and second additional lines being in the male nearly, and in the female fully, as well marked as the proximal line. In this character *H. r. somalicum* represents an ancestral stage.

The genitalia do not appear to differ from those of *H. r. roseipennis*.

Mandera.—1909: Oct. 14,—1 ♀.

Hargaisa.—1909: Nov.,—1 ♂ (type).

HIPPOTION ROSÆ Butl.

Darapsa rosæ Butl. A. M. N. H. (5) x. p. 433. n. 5 (1882).

1909: Oct. 6,—1 ♂.

Fam. NOTODONTIDÆ.

GARGETTA XYLOCHROA Hmps.

Mandera.—1908: May 29,—1 ♀; Nov. 22,—1 ♂. 1909: Feb. 17,—1 ♂.

Hargaisa.—1908: Oct.,—1 ♂.

SCRANCIA DISCOMMA, sp. n. (Pl. II. fig. 10, ♀.)

♀. Head and thorax white mixed with reddish brown and blackish, the patagia white slightly pencilled with brown; pectus and legs white with a few brown scales; abdomen white tinged with brown and with slight lateral blackish spots except towards extremity. Fore wing white irrorated with a few black scales, the inner half tinged with red-brown, the veins streaked with black except on basal and inner areas and at costa; a small round black-brown discoidal spot surrounded by white. Hind wing white, the terminal area tinged with brown, broadly at costa, narrowing to tornus; cilia white, faintly tinged with brown. Underside of fore wing suffused with brown, the terminal area whiter; hind wing with the costal area suffused with brown.

1908: Oct. 15,—1 ♀ (type). *Exp.* 35 millim.

STENOSTAURA IMPEDITUS Wlk.

1908: Feb. 24,—1 ♀.

Fam. GEOMETRIDÆ.

By LOUIS B. PROUT.

These form, on account of the number of new and interesting species, an extremely important part of Mr. Feather's collection. Their general affinities, as might be expected, are with the fauna of Abyssinia, British East Africa, and to some extent Socotra

and Southern Arabia, and desert forms are strongly in evidence. Nearly all the species are of small size, the majority belong to a few groups (especially Acidaliids and the *Macaria* group), and one extensive subfamily (the Larentiinae) is almost absent, being represented by only two specimens, while even of these one is the somewhat anomalous *Pseudosterrha philcearia*. The presence, in the groups named, of a number of closely allied and inconspicuous species (in some cases also strongly variable) has rendered a satisfactory working-out of the material a matter of no small difficulty; and this difficulty has been increased by a curious and unexplained circumstance which deserves mention—the very marked preponderance of females; this sex alone being represented in not a few cases where there is quite a good series of examples. We are not unaccustomed to meeting with Geometrid collections in which the *males* alone of many species are present, and are able readily to attribute this to the greater activity of the sex, the fact that the collection was made chiefly at light, and so on; but it is less easy to suggest what difference in habit, or what particular method of collecting, has resulted in the capture of the *females* only of so many species. That the phenomenon is not confined to a single genus or group will be seen by referring to the details given below, under *Hierochthonia featheri*, *Acidaliastis subbrunnescens*, *Tephрина*, nearly the whole of the Acidaliinae, etc.*

Subfam. HEMITHEINÆ.

Ten species are represented, most of them more or less highly specialised forms, and including two additions to the handful of known species in which the characteristic green colour of the subfamily has given place to some shade of brown or sand-colour.

VICTORIA SEMATOPERAS, sp. n. (Pl. II. fig. 26, ♂.)

♂ ♀, 32–33 mm. Face and upper side of palpus dark red; crown of head, base of antenna, and basal one-third or more of costa red mixed with lustrous blue-blackish scales. Abdomen dorsally slightly reddish, crests lustrous, pale on summit, then reddish, a deep black spot (dot) near base of each. Fore wing with termen almost smooth; green (in all three discoloured by relaxing); discal dot white, encircled with a black-dusted red ring; distal margin with similarly coloured dark spots, namely a small one in front of R^1 , a much larger one from R^1 to beyond R^2 , and a small or moderately large one at tornus. Hind wing with the excision between the radials not deep, discal dot as on fore

* [After the above paragraph was written a number of additional specimens of Geometridæ were set and added to the collection. Mr. Prout wrote (Feb. 19, 1915), concerning these additions:—"They do not upset my generalisation as to the preponderance of females; indeed, they rather strengthen it, being almost exclusively of that sex except in one species (*Heterostegane indularia*) whose males were already well in evidence." On this subject see also p. 93.—E. B. P.]

wing or less clearly ringed, tornus with indications of dark markings. Fore wing beneath with the terminal markings weakly indicated, hind wing quite unmarked.

1909: Mar. 14,—1 ♀; Dec. 30,—1 ♂ (type). **1910:** Jan. 2,—1 ♀.

Unfortunately all have lost the hind legs. It is evidently a near ally of *V. triplaga* Prout, from German East Africa.

PRASINOCYMA PERPULVERATA, sp. n. (Pl. II. fig. 25, ♂.)

♂ ♀, 16–21 mm. Palpus in male rather slight for the genus, in female about $1\frac{1}{2}$ times diameter of eye, with 3rd joint exposed but rather short for the genus. Antenna of male with the outer pectinations longish, the inner much shorter. Hind tibia of male not dilated, the four spurs closely approximated. Head, body, and legs concolorous with wings, the vertex appreciably paler than the face. Wings rather narrower than in typical *Prasinocyma*, hind wing not at all bent at R^3 , cells relatively long (fully one-half); fore wing with SC^1 generally free, R^1 not or very shortly stalked, M^1 connate or very shortly stalked, hind wing with two stalkings. White-grey with a slight tinge of brown, coarsely irrorated with fuscous, the irroration under a lens inclining to resolve itself into minute longitudinal strigulae; cell-spots strong, elongate. Under surface less strongly irrorated.

Apparently variable, the name-typical form, with uniform irroration, the commonest; here I refer the following:—

Mandera.—**1908:** June 1,—1 ♀; July 17,—1 ♀; Sept. 27,—1 ♂, 1 ♀. **1909:** May 10,—2 ♀, 1 ♂ (type).

Three females show on the fore wing an ill-defined dark basal patch, dark median band from hind margin about to cell, and dark terminal dashes between the veins: ab. *subfasciata*, ab. n.

Mandera.—**1909:** May 10,—1 ♀. **1910:** Mar.,—1 ♀ (type);

Hargaisa.—**1908:** Oct.,—1 ♀.

One male is smaller (16 mm.) and with still more markings; the median area being broadly dark-mixed in *anterior* half, a dark proximal shading (forming a large, strong spot at costa) indicating the position of the obsolete subterminal line, the hind wing somewhat shorter, with distal area somewhat darkened, the antennal pectinations apparently continuing slightly less far down the shaft: ab. *perscripta*, ab. n. (? sp. div.).

Mandera.—**1908:** July 17,—1 ♂ (type).

By the length of the cells and the female palpus, as well as by the facies (which recalls *Neromia pulvereisparsa* Hmps.), *perpulverata* should probably be made the type of a new genus.

CHLORISSA STIBOLEPIDA (Btlr.)*.

Comibæna stibolepida Btlr. Cist. Ent. ii, p. 394 (1879).

* [The parentheses around the names of authors placed after scientific names in this paper are used in accordance with Article 23 of the International Rules of Nomenclature (Proc. 7th Int. Cong., Boston 1907, p. 44 (1912)).—EDITOR.]

Hemithea albistrigulata Warr. Nov. Zool. iv. p. 39 (1897).

Hemithea vermiculata Warr. ibid. p. 41 (1897) (n. syn.).

1909: Apr. 20,—1 ♀; Apr. 24,—1 ♀.

A very widely distributed African species, and perhaps not structurally differentiable from *C. faustinata* Mill. (S. Palæarctic) and *C. solidaria* Guen. (Indian).

NEROMIA MALESCRIPTA (Warr.).

Hemithea malescripta Warr. Nov. Zool. iv. p. 40 (1897).

1903: Nov. 13,—1 ♂. 1909: Mar. 1,—1 ♂.

Both examples small, with the crests red.

Distributed in Abyssinia, British East Africa, Transvaal, and Natal. I have a note, dealing with the difficult group to which this species belongs, in the press for the 'Annals of the Transvaal Museum.'

NEROMIA MANDERENSIS, sp. n. (Pl. II. fig. 24, ♀.)

♀, 20–22 mm. Face and palpus red. Vertex and antenna whitish, the latter with minute ciliation; occiput green. Thorax and abdomen concolorous with wings. Wings above green with whitish strigulation, quite like the greenest forms of *Chlorissa stibolepida* Btlr., costal edge of fore wing ochreous, otherwise markingless; fringes green, lighter distally. Under surface paler green, costal edge of fore wing as above.

Mandera.—1903: Sept. 25,—1 ♀ (type); Nov. 13,—1 ♀. 1909: May 8,—1 ♀.

Hargaisa.—1908: Oct.,—1 ♀ (a worn example).

Hind wing less elongate than in *Chlorissa stibolepida*, termen smoothly rounded; but best distinguished by the structure. Palpus reaching beyond frons and shortly rough-scaled, but with 3rd joint small; hind tibia with terminal spurs only. If the male antenna should prove to be pectinate, the species should be considered a *Microloxia*, aberrant in the rather short 3rd joint of the palpus.

Genus HEMIDROMODES, nov.

Palpus slender, in male rather short, in female moderate, in both sexes with 3rd joint short or shortish. Tongue absent. Antenna short and rather thick, in male with moderate, in female with short pectinations. Pectus somewhat hairy; hind tibia in male short, greatly dilated (recalling that of *Synclismus*), all the spurs present, terminal very short, the outer almost obsolete; in female with terminal spurs well developed, median short, sometimes entirely absent. Abdomen not crested, in female robust. Frenulum in male slight, in female absent. Fore wing with SC¹ from cell, free, R¹ about connate with SC²⁻³, R² rather far forward, M¹ about connate or very shortly stalked with R³. Hind wing with termen smooth, C anastomosing to

scarcely one-half cell, DC not very oblique, SC² well stalked, R² little before middle of discocellulars, M¹ well stalked.

Type of the genus: *Hemidromodes robusta* Prout (*Hierochthonia*).

A connecting link between *Hierochthonia* and *Syndromodes*; the absence of the male, and the curious fact that the female examined had no trace of median spurs (though both legs are in good condition), led me to refer the species to the former genus. From *Syndromodes* it differs in antenna, male hind leg, robust female abdomen, etc.

HEMIDROMODES ROBUSTA (Prout).

Hierochthonia robusta Prout, Nov. Zool. xx. p. 435 (1913).

6 ♂, 14–18 mm.; 6 ♀, 18–24 mm.

1908: June 1,—2 ♂; July 17,—1 ♂; July 31,—1 ♀; Aug. 24,—1 ♂. 1909: Jan. 16,—1 ♀*; Mar. 19,—1 ♀; Mar. 24,—1 ♀; Apr. 11,—1 ♂; May 10,—1 ♂; May 21,—1 ♀; Nov. 7,—1 ♀*.

Excepting the two females marked *, all are smaller—mostly considerably smaller—than the type specimens from Port Sudan.

In this species the fringes (which in neither of the originals were quite perfect) are long, proximally green, distally ochreous whitish.

HIEROCHTHONIA FEATHERI, sp. n. (Pl. II. fig. 23, ♀.)

♀, 24–26 mm. Face green. Palpus minute, whitish. Tongue vestigial. Antennal shaft white, pectinations long. Vertex white; occiput green. Thorax above green, beneath white. Abdomen robust, dorsally green, becoming white posteriorly and ventrally. Fore wing moderately broad, SC¹ from cell, anastomosing with C, SC² from shortly after R¹, anastomosing with SC¹, R¹ well stalked, R² rather extremely placed, M¹ shortly stalked; uniform bright green, nearly as the genus *Euchloris* or slightly more bluish, distal one-third of fringe white. Hind wing moderately broad, costal margin rather long, apex rounded, C anastomosing to near end of cell, R² rather extremely placed, M¹ short-stalked; green, rather paler than fore wing, especially towards base and costal margin. Under surface pale green.

1908: Nov. 20,—1 ♀. 1909: Jan. 15,—1 ♀; Jan. 16,—1 ♀; Jan. 22,—1 ♀; Apr. 10,—1 ♀; Apr. 12,—1 ♀; Apr. 15,—1 ♀; Apr. 22,—1 ♀; May 9,—1 ♀ (type); Dec. 10,—1 ♀.

Probably related to *petitaria* Chr., notwithstanding the broader wings and strongly pectinate antenna. It is unfortunate that the males in this group are still unknown.

COMOSTOLOPSIS STILLATA (Feld.).

Nemoria stillata Feld. Reise Novara, Lep. Het. t. 127. fig. 17 (1875).

Eucrostes rubristicta Warr. Nov. Zool. vi. p. 23 (1899).

Proc. Zool. Soc.—1916, No. X.

Eucrostis rufostellata Mab. Ann. Soc. Ent. Fr. lxxviii, p. 740 (1900).

1909: May 21,—1 ♀.

A quite typical example of this widely distributed African species, extending its known range.

EUCROSTES ASTIGMATICA, sp. n. (Pl. II. fig. 22, ♀.)

♂, 15–16 mm.; ♀, 19–20 mm. Superficially very like *pygmæa* Rbl.* (= *insularis* Prout), but larger, of a still more vivid green, and without the discal dots, the pale postmedian line not discernible, or only suggested in certain lights. "Snow-white," in my description (Gen. Ins. cxxix. p. 246) of the costal edge, was not absolutely accurate, as there is, in a good light, a very delicate tinge of pinkish or violet in the white in both species. Structurally like the African members of the genus, the male palpus being less minute than in *pygmæa*, the 3rd joint in the female rather less long and slender, and the female antenna bipectinate, the longest branches about twice as long as the diameter of the shaft.

1908: Sept. 21,—1 ♂. 1909: Apr. 21,—1 ♂ (type); Apr. 22,—1 ♀; May 10,—2 ♀.

ACIDALIASTIS SUBBRUNNESCENS, sp. n.

♀, 14–16 mm. Much more strongly and uniformly dusted with sand-colour (sometimes more yellowish, sometimes more brownish) than *micra* Hmps., the dark lines only weakly (in the darkest example scarcely at all) indicated, but with very conspicuous white lines proximally to the first and distally to the second; the former of these is more oblique than in *micra*, not reaching costa, the latter forms a rather more appreciable curve than in that species; *discal dot absent*. Hind wing white, becoming more or less tinged with sand-colour towards termen, in the darkest-marked example showing a curved white postmedian line. Fore wing beneath with white outer line and white hind margin, hind wing all white.

1908: June 1,—1 ♀; June 29,—1 ♀; Sept. 14,—1 ♀ (type); Sept. 17,—1 ♀; Sept. 23,—1 ♀. 1909: Mar. 24,—1 ♀.

Very near *bicurvifera* Prout (Ann. Transv. Mus., in the press), much smaller, costa rather straighter, apex rather less sharp, termen rather less convex in posterior half, palpus and female antennal pectinations slightly shorter, markings less reddish (more olivaceous), postmedian line almost parallel with termen (in *bicurvifera* more oblique), hind wing rather shorter, less unicolorous, face apparently less reddish.

* Denks. Akad. Wien, Math.-nat. Kl. lxxi. 2, Sep. p. 67 (1907). As only separata in advance seem to have been issued of the paper of Rebel's containing this species, and it was not noticed in the 'Zoological Record,' I do not feel to blame for having overlooked it in the 'Genera Insectorum' and created a synonym.

Subfam. ACIDALIINÆ.

Genus TRICENTROSCELIS, nov.

Face rounded, markedly prominent, with appressed scales. Palpus short, shortly rough-scaled. Tongue present. Antenna in female minutely ciliated. Pectus and femora glabrous. Hind tibia in female with a single proximal and a pair of terminal spurs, all of moderate length. Wing-shape and facies of *Acidalia*, distal margins smooth. Fore wing with SC^2 from cell, anastomosing with SC^1 and then very strongly with SC^{3+4} (*i. e.* areole double and SC^1 and SC^5 arising before and behind the apex of the distal areole), M^1 well separate from R^3 . Hind wing with C normal, SC^2 very shortly stalked or almost connate with R^1 , M^1 well separate from R^3 .

Type of the genus: *Tricentroscelis protrusifrons*, sp. n.

Differs from the Neotropical *Scelolophia* Hulst (= *Calypotome* Warr. = *Crypsitila* Warr.), which also has often a 3-spurred female hind tibia, in the protuberant face and longer cells.

TRICENTROSCELIS PROTRUSIFRONS, sp. n. (Pl. II. fig. 21, ♀.)

♀, 21 mm.. Face fuscous. Palpus fuscous, not quite reaching extremity of frons. Vertex and antenna similarly coloured to wings, but rather paler; antennal ciliation minute. Thorax concolorous with wings. Abdomen slightly paler, 2nd-4th segments mostly occupied dorsally by a large fuscous blotch, the later segments interruptedly marked with fuscous dorsally. Fore wing with apex and termen somewhat rounded; reddish brown (light grey-brown irrorated with rufous and blackish); antemedian line indicated by rufous and blackish scales, accentuated by black spots on costa and hind margin and dots on the veins, arising before one-third costa, bent in cell, becoming oblique inwards and sinuous; discal dot small but sharp; median shade obsolescent, placed between discal dot and postmedian line, slightly more distinct as a costal dot, outbent at radials, inbent at fold; postmedian from costa slightly beyond two-thirds, faint except at costa and veins, where it is marked by black dots, angled at SC^5 , then strongly oblique outwards to R^1 , then more parallel with termen, but slightly sinuate inwards at R^2 and more strongly at fold; terminal dots strong, black; fringe somewhat dusted with blackish, a slender clear line at base. Hind wing with termen almost smooth, very slightly sinuous towards anal angle; concolorous with fore wing, discal dot slightly larger, median shade much stronger, nearly straight, proximal to the discal dot, antemedian wanting, the rest as on fore wing. Under surface slightly paler, the discal and terminal dots and postmedian line reproduced, though less sharp; hind wing in addition with median shade indicated at abdominal margin.

1909: Apr. 6,—1 ♀ (type).

Superficially similar to some African *Acidalia* (*exiguaria* group) or *Ptychopoda* (*sinuilinea* Prout, etc.).

TRAMINDA RUFISTRIGATA (Hmps.).

Ephya rufistrigata Hmps. Proc. Zool. Soc. Lond. 1896, p. 267, pl. x. fig. 3.

1908: Sept. 28,—1 ♀. 1909: Apr. 14,—1 ♀.

Described from Aden; distributed as far as British East Africa. As the male hind tibia has all spurs present, the species must be removed to *Traminda*.

TRAMINDA NEPTUNARIA (Guen.).

Timandra neptunaria Guen. Spec. Gén. Léop. x. p. 3, t. 18. fig. 5 (1858).

Timandra viridaria Walk. List Lep. Ins. Brit. Mus. xxiii. p. 800 (1861).

Gnamptoloma neptunaria Warr. Nov. Zool. ii. p. 95 (1895).

Traminda neptunaria Swinh. Tr. Ent. Soc. Lond. 1904, p. 562.

Mandera.—1909: Apr. 5,—1 ♂; Apr. 27,—1 ♀.

Hargaisa.—1908: Oct.,—1 ♂.

Widely distributed in Africa.

CHLORERYTHRA RUBRIPLAGA Warr.

Chlorerythra rubriplaga Warr. Nov. Zool. ii. p. 91 (1895).

1908: Sept. 19,—1 ♀; Oct. 25,—1 ♀. 1909: Feb. 15,—1 ♀; Feb. 22,—1 ♀; Mar. 14,—1 ♂; May 10,—1 ♀. 1910: Jan.,—1 ♀.

The male and two females (22 Feb. and 10 May) belong to the plain green form with the oblique red line almost entirely obsolete; the other four females have the line distinct, the ground-colour showing the three gradations well known in this group (green, green irrorated with rufous, rufescent). Doubtfully distinct generically from *Traminda*. Widely distributed in Eastern Africa.

ACIDALIA MINOA, sp. n. (Pl. II. fig. 20, ♀.)

♀, 20 mm. Unfortunately (like so many of the species) without the male, but showing sufficient peculiarities to render it safe to describe it. Absolutely without markings, very glossy, otherwise bearing a good deal of superficial resemblance to a worn female of *Minoa murinata* Scop., though with narrower wings; similarly coloured; the fore wing beneath with a smoky suffusion, which is also slightly indicated on the upper surface at certain angles of light. Head and body slightly more ochreous than wings, the face and palpus sharing this colour, not—as in the majority of *Acidalia*—black or fuscous. Abdomen rather robust. Venation rather variable, SC¹ of fore wing arising from just before apex of areole or well stalked with the other subcostals; C of hind wing not rapidly diverging from SC, sometimes anastomosing at slightly more than a point; SC² in two of the examples extremely shortly stalked with R¹. Termen of hind wing not at all bent in middle.

1909: Apr. 7,—1 ♀ (type); Apr. 9,—1 ♀; Apr. 23,—1 ♀.

I suspect this may prove to belong to the less specialized section *Pylarge* (male hind tibia with terminal spurs).

ACIDALIA MINORATA (Bsd.).

Geometra (*Idea*) *minorata* Bsd. Nouv. Ann. Mus. Hist. Nat. ii. p. 263 (1833).

? *Acidalia remotata* Guen. Spec. Gén. Lép. ix. p. 458 (1858).

Acidalia consentanea Walk. List Lep. Ins. Brit. Mus. xxii. p. 745 (1861).

? *Acidaliu actuarial* Walk. ibid. p. 752 (1861).

? *Acidalia derusata* Walk. ibid. xxvi. p. 1604 (1862).

1908: July 17,—1 ♀; Sept. 11,—2 ♀; Sept. 13,—1 ♀; Sept. 25,—1 ♀; Sept. 30,—1 ♀; Oct. 11,—1 ♀; Oct. 20,—1 ♀; Nov. 24,—1 ♀. 1909: Jan. 12,—2 ♀; Oct. 20,—2 ♀; Oct. 29,—1 ♀; Nov. 16,—1 ♀.

All fifteen females referable, so far as present knowledge is available, to this very common, very widely distributed, and moderately variable species. On an average, the lines are less crenulate and more concise than in the most typical forms, and as there is some slight variation in the breadth of the wings, as well as in the tone of colour and strength of markings, I am not prepared to say that there may not be two or three species mixed. One or two examples, in the sparseness of their irroration, recall *lactaria* Walk. (List Lep. Ins. xxii. p. 744), which, however, is possibly also only an aberrant form of *minorata*. Distributed throughout Africa, except, perhaps, the extreme north-west; also eastward to Aden and, if *actuarial* is really the same species, to India and Ceylon.

ACIDALIA SPOLIATA Walk. (?).

Acidalia spoliata Walk. List Lep. Ins. Brit. Mus. xxii. p. 744 (1861).

1908: Nov. 22,—1 ♀.

The single example is of the *minorata* group, larger than that species, somewhat less reddish and more marked than *internataria* Walk. (List Lep. Ins. xxii. p. 746), very likely a deeply coloured form of *spoliata* Walk. (from S. Africa), or, perhaps, a form of the widely distributed Oriental species, *nesciaria* Walk. (List Lep. Ins. xxii. p. 750).

ACIDALIA HORIOCHRÆA, sp. n.

♀, 20–23 mm. Face blackish. Palpus white beneath, dark-mixed above. Vertex white. Collar pale ochreous. Thorax, abdomen, and legs concolorous with wings, fore femur and fore tibia infuscated above. Fore wing of medium breadth, with apex moderately pointed; dirty white, irrorated (variably in strength in the different individuals) with brown-grey; lines moderately

strong, though resolving themselves under the lens into condensed irroration; antemedian slender, generally indistinct anteriorly, oblique outwards from one-third costa, strongly recurved in cell, oblique inwards to about one-fourth hind margin, faintly sinuous; discal dot small but sharp; median line thicker than the others, well beyond discal dot, very strongly oblique outwards from costa, very sharply bent subcostally, thence very slightly obliquely inwards and sinuous, the sinuities being, as usual, at the folds, but never very deep, sometimes scarcely appreciable; postmedian fine, midway between median and termen or slightly nearer to the former, parallel with termen except at costa, where it makes a bend, though less sharply than the median, sinuities slight or very slight; subterminal indicated by absence of irroration, accompanied proximally by a band of stronger irroration, distally by a *band of browner tone*, sometimes partly obscured by the grey irroration, but always noticeable, usually clearest anteriorly, not rarely showing a bright brown, almost ferruginous spot near apex; a narrow white line separates this band from the terminal line, which is black, thickest between the veins, slightly interrupted at the veins and *extends round the apex* for some distance along the costa, as in the *submutata* group; fringe with a line of stronger irroration beyond the middle, distally hereto less strongly irrorated than proximally. Hind wing with termen not bent at R^3 ; first line absent; median just proximal to discal dot, obsolete anteriorly; postmedian slightly sinuous, nearly parallel with termen; distal area nearly as on fore wing, the brownish band fading out at apex instead of becoming more conspicuous, the terminal line not extended round apex; fringe as on fore wing. Under surface more weakly marked, that of fore wing somewhat suffused basally, that of hind wing whiter; first line and sometimes median shade obsolete or nearly so.

1908: Aug. 24,—2 ♀. 1909: Jan. 16,—1 ♀; Jan. 19,—1 ♀; Feb. 18,—1 ♀; Feb. 19,—1 ♀; Apr. 22,—1 ♀; May 10,—1 ♀; May 29,—1 ♀; Aug. 17,—1 ♀; Sept. 17,—1 ♀ (type); Dec. 30,—1 ♀. 1910: Jan. 8,—1 ♀; Jan. 12,—1 ♀.

A very distinct though unostentatious little species, recognizable especially by the characters printed in italics.

ACIDALIA (PYLARGE) NEPHELOPERAS, sp. n.

♂, 16–23 mm.; ♀, 19–23 mm. Superficially like *Glossotrophia romanaria* Mill., and *rufomixtata* Rbr., but structurally an *Acidalia* of the section *Pylarge*. Best described by a comparison with the well-known *A. submutata* Tr., with which it entirely agrees in the markings (though these are, on an average, more sharply expressed), including the continuation of the black terminal line round the apex, and the tendency (sometimes very strong) to blue-grey clouding in the distal area. Much smaller; ground-colour varying from ochreous whitish to reddish sand-colour (much as in *pulchellata* Fab.), antennal ciliation in both sexes longer, male hind tibia with a pair of spurs, face pale in lower

half, termen of fore wing slightly more curved, of hind wing not subcrenulate; terminal line accompanied proximally by a fine whitish line (as in *pulchellata*), and on the fore wing expanded into a large triangular dot anteriorly to SC⁵, fringe more strongly dark-dotted than in *submutata*; under surface glossy, that of hind wing scarcely paler than that of fore wing, discal dots rarely quite obsolete, fore wing generally with noticeably darkened border distally.

1908: Feb. 13,—1 ♀; Sept. 15,—1 ♂; Sept. 22,—1 ♀; Nov. 13,—1 ♀. 1909: Jan. 12,—1 ♀; Jan. 20,—1 ♀; Feb. 18,—1 ♂; Mar. 24,—1 ♂ (type); Apr. 14,—1 ♀.

There is also a male from Port Sudan (*Mrs. E. N. Waterfield*) in coll. Brit. Mus., and a larger one from Bhuj Kutch (*Lt.-Colonel C. G. Nurse*).

Rather variable in colour and in the strength of the markings. Related to *Acidalia (Pylarge) ocellicincta* Warr. (Nov. Zool. viii. p. 9), from British East Africa.

ACIDALIA PULCHELLATA Fab.

Phalena pulchellata Fab. Ent. Syst. iii. (2) p. 171 (1794).

Acidalia addictaria Walk. List Lep. Ins. Brit. Mus. xxii. p. 749 (1861).

Craspedia addictaria Hmps. Faun. Ind., Moths, iii. p. 429 (1895).

?*Craspedia rufinubes* Warr. Nov. Zool. vii. p. 91 (1900).

1908: May 4,—1 ♂. 1909: Mar. 24,—1 ♀; Apr. 24,—1 ♀; May 6,—1 ♀. 1910: Mar. 18,—1 ♀.

Mostly of a more ruddy form than the Indian. The British Museum collection has one quite similar from Aden.

ACIDALIA TIMIA, sp. n. (Pl. II. fig. 19, ♀.)

♀, 21–26 mm. Face blackish fuscous, very narrowly pale-edged beneath. Palpus fuscous above, pale beneath. Antenna (as in *nepheloperas*) unusually strongly ciliated for a female, the cilia fully one-half as long as diameter of shaft. Vertex, thorax, and abdomen concolorous with wings; collar ochreous. Fore femur darkened on upper side. Fore wing with apex not very sharp, termen straight anteriorly, gently curved posteriorly, not extremely oblique; palest fleshy ochreous, rather glossy (similar to *beckeraria* Led., but still paler), without dark irroration, but in places slightly clouded with less whitish fleshy-ochreous; antemedian and median lines (or narrow shades) ochreous, very feeble, sometimes almost entirely obsolete, the former sometimes marked with darker dots on SC, M, and SM²; discal dot usually distinct, sometimes elongate, placed on the median shade; postmedian line fine and faint, but marked with fuscous dots on the veins (a larger one at costa), shaped about as in *beckeraria*; darker ochreous, fuscous-dotted spots or patches commonly follow the postmedian between the radials and at posterior margin; terminal line ochreous, very feeble, especially posteriorly; fringe

concolorous, in strongly marked specimens with dark ochreous or even fuscous-mixed dots. Hind wing with termen smooth; concolorous with fore wing, discal dot and postmedian row of dots present, the latter followed by a not very strong band of ochreous shading. Under surface glossy, slightly less pale ochreous (especially the fore wing), without markings.

1908: Mar. 24,—1 ♀; Aug. 15,—1 ♀; Sept. 26,—1 ♀. **1909:** Jan. 14,—1 ♀; Jan. 20,—1 ♀; Apr. 16,—1 ♀; Apr. 20,—1 ♀; May 8,—1 ♀; Oct. 7,—1 ♀ (type). **1910:** Jan. 8,—1 ♀.

Apart from the colour, and the presence of dark cloudings distally to the postmedian line, this neat little species differs from *beckeraria* in having the termen of the fore wing, on an average, less oblique.

ACIDALIA PYRRHOCHRA, sp. n. (Pl. II. fig. 18, ♀.)

♀, 23–25 mm. Structure of the preceding. Face blackish fuscous (in all three examples badly abraded below). Shape and essential markings of *timia*, of which it might possibly be an extraordinarily different colour-form, unconnected with the name-type by any transitions. Strongly rufous ochreous, as in *fulvicolor* Hmps. (Nat. Hist. Socotra, p. 331), or the most rufous aberration of *nepheloperas* Prout, in two of the examples finely irrorated with blackish, in the other more uniform; in place of the two ochreous patches which characterize *timia* there is a continuous black-grey clouding proximally to the dentate subterminal line (which is, in consequence, distinctly expressed), and some slighter shading distally to the same—altogether recalling certain forms of *marginepunctata* Goeze, *nepheloperas* Prout, etc., more than *timia*. Under surface rather paler than upper, the distal cloudings faintly indicated in greyish.

1908: Oct. 30,—1 ♀ (type). **1909:** Apr. 9,—1 ♀; Nov. 16, 1 ♀.

The last-mentioned (the example without blackish irroration) is further aberrant in having the distal cloudings extremely weak, the discal dot of the fore wing surrounded by an ill-defined deeper reddish spot, that of the hind wing very minute. Easily distinguished from the reddest form of *nepheloperas* by the absence of black terminal line and triangular subapical dot, etc.

ACIDALIA LURIDATA (Zell.).

Idea luridata Zell. Isis, 1847, p. 20 (*nec* Stgr.).

Acidalia canosaria Led. Verh. zool.-bot. Ver. Wien, v. p. 209, t. 3. fig. 3 (1855) (ab.).

Acidalia luridata Prout, Seitz Macrolep. iv. p. 64, t. 4 e (1913).

1908: July 31,—1 ♀; Aug. 25,—1 ♀. **1909:** Jan. 12,—1 ♀; Feb. 22,—1 ♂; May 8,—1 ♂; Sept. 18,—1 ♀; Oct. 24,—1 ♀.

Fairly typical, *i. e.* rather darker than, and not quite so reddish as, the form *canosaria* Led., which is the more general in S. Europe and Asia Minor. The distribution of the species

extends from Greece and Northern Egypt to Zerafshan and N.W. India, and the British Museum has an example from Yemen, Arabia, but the present specimens extend its known range in Africa.

ACIDALIA SAGITTILINEA (Warr.).

Craspedia sagittilinea Warr. Nov. Zool. iv. p. 219 (1897).

1909: Feb. 15,—1 ♂; Feb. 16,—1 ♂; Feb. 17,—1 ♂.

Described from Mombasa, and I have seen a few from other localities in British East Africa. Both these Somaliland examples are rather less strongly marked (especially beneath), the median shade faint, placed midway between discal dot and post-median line.

GLOSSOTROPHIA DISPARATA SOMALIATA, subsp. n.

♀, 17–19 mm. Name-typical *disparata* Hmps. (Nat. Hist. Socotra, p. 332, *Craspedia*) has never been described, its recognition hitherto depending on a good, though uncoloured figure (ibid. t. 20. fig. 18), and a note by Rebel (Denks. Akad. Wien. Math.-nat. Kl. lxxi. 2, Sep. p. 69) to the effect that it belongs to the *confinaria* group of *Acidalia* (i. e. *Glossotrophia* Prout), and that the male antenna might almost be called shortly pectinate (i. e. subdentate with fascicles of cilia). It is the smallest of the genus; male hind tibia with one spur, hind wing slightly less regularly rounded than in the typical species (slightly bent at R³); sand-colour with dense dark irroration, not “fluted” as in *romanaria* Mill., terminal line (except towards apex) broken into very short, strong dashes, at and round apex fine and less pronounced than in most of the species. *Face concolorous*. Palpus dark-mixed on outer side. Tongue moderately long. Subsp. *somaliata* (bon. sp.?) is rather larger, fore wing slightly longer, irroration much lighter, showing a feeble tendency towards the “fluting”; terminal dashes more slender and less black, apical line somewhat more pronounced. Palpus with less dark spotting on outer side.

1908: Sept. 14,—1 ♀. 1909: Jan. 11,—1 ♀ (type).

ZYGOPHYXIA TORNISECTA, sp. n.

♂, 14 mm.; ♀, 16–19 mm. Face and palpus fuscous. Tongue slender, rather short. Antennal ciliation in male moderately long. Vertex white. Collar white, with a slight ochreous tinge. Thorax, abdomen, and legs concolorous with wings. Hind tibia in both sexes with terminal spurs. Wings less narrow than in *relicata* Walk. (the type of the genus); fore wing only slightly, hind wing decidedly, narrower than in *elongaria* Rbr., which in some respects it rather recalls; hind wing with shallow, rounded excision from M² to tornus, inner margin consequently shortened. Dirty white with a tinge of brownish, and with moderately strong fine brown-grey irroration; discal dots small, black; lines generally not sharply defined (in the male particularly weak),

those of the fore wing approximately parallel with the termen, the slender antemedian and broad (sometimes strong) postmedian perhaps slightly more oblique and with a strong proximal bend at costa, the median touching the distal edge of the cell-dot, postmedian slender, proximal subterminal broad, distal subterminal very weak; first line of hind wing absent, median shade rather straight, except the sharp anterior bend; termen with black dots between the veins; fringe dusted with fuscous, most thickly opposite the veins, a fine pale line at its base, a broader one just beyond the middle. Underside similar or more blurred.

1908: Aug. 15.—1 ♀. 1909: Feb. 28,—1 ♂ (type); Mar. 24,—1 ♀; Apr. 15,—1 ♀.

PTYCHOPODA SUBTORRIDA, sp. n. (Pl. II. fig. 17, ♀.)

♀, 18 mm. Face and palpus black. Vertex, antenna, thorax, abdomen, and fore leg concolorous with wings (other legs lost). Fore wing rather narrow; light ochreous brown, almost entirely suffused with vinous, less so basally and costally; scattered black irroration; lines black; antemedian from one-fourth costa, oblique outwards, very acutely angled in cell, then equally oblique inwards to behind M, thus forming a V-mark, a second, much shorter angle outwards at fold, but the entire posterior half of the line less strong, more dissolved into coarse black dots; median line from mid-costa, sinuous in S-shape, the anterior (outward) curve crossing the deep-black cell-spot; postmedian from costa at nearly three-fourths, forming an inward curve or bend at first, sharply angled outwards at R¹ (forming a shorter V than the antemedian), weakly incurved between the radials and boldly between M¹ and SM², finally oblique inwards at hind margin; distal area with blackish cloudings, the most conspicuous being one at R¹ (interrupted at the position of the obsolete subterminal line) and a longitudinally elongate pair on either side of M¹; no terminal line; fringe very long, its proximal half light ochreous brown, opposite the veins with amorphous spots formed of groups of black dots, distal half paler and somewhat greyer, unmarked. Hind wing rather narrow, with termen almost smooth, not very strongly convex; more strongly irrorated than fore wing, especially at base; first line not developed; median thick and somewhat diffuse, proximal to the sharp black cell-spot; postmedian as on fore wing, but with the angle at R¹ less pointed; distal area with two somewhat sinuous bands of dark irroration, enclosing a pale subterminal line; fringe as on fore wing. Under surface considerably paler, costal margin of fore wing finely dark-dusted, the rest rather smooth and glossy; both wings with strong discal spot (larger than above) and a moderately strong outer line, starting from a slightly enlarged spot at costa which corresponds to the origin of the postmedian of upper surface, but oblique outwards, bent about R¹, thence approximately parallel with termen, corresponding to the proximal subterminal dark shade of the hind wing above; fringe unspotted.

1909 : Mar. 24,—1 ♀ (type).

Near *torrida* Warr. (Nov. Zool. xi. p. 468), termen of hind wing less protuberant, antemedian line more acutely angled, not connected with median by dark shading, under surface more strongly marked.

PTYCHOPODA NIGROSTICTA Warr. (?).

Ptychopoda nigrosticta Warr. Nov. Zool. iv. p. 61 (1897).

1908 : Feb. 24,—1 ♀ (rather worn).

The large discal dots and the markings, so far as they can be made out, suggest the more mottled forms of this species, but the former are perhaps somewhat exaggerated, the wings are rather more coarsely dusted, with stronger dark markings near the termen, the underside with the cell less infuscated and with the spot near the tornus apparently wanting. Described from Natal and occurs in the Transvaal and, perhaps, British East Africa, but it is by no means certain that these more northerly specimens belong here: they may be slightly narrower winged. Good specimens, and especially the male, must be awaited.

PTYCHOPODA sp.

1908 : Aug. 26,—1 ♀. Rather rubbed.

Probably new, unless it be a form of *subpurpurata* Stgr. (from Syria, etc.). Rather uniform reddish sand-colour, very weakly marked; fore wing with traces of a strongly sinuous darker median line, hind wing with fine, strongly sinuous postmedian line; both these lines marked with some fuscous dusting.

PTYCHOPODA APERTA, sp. n. (Pl. II. fig. 16, ♂.)

♂, 17 mm. Face dark fuscous. Palpus short and slender, dark fuscous. Tongue slight. Antennal ciliation scarcely longer than diameter of shaft. Head, body, and legs about concolorous with wings; fore leg fuscous above; abdomen dorsally belted with fuscous. Fore wing with all the subcostals on a common stalk, through suppression of distal wall of areole (base of SC³⁻⁵); brown with a tinge of reddish and with rather coarse blackish-fuscous irroration, mainly longitudinal in direction; base more strongly irrorated costally; first line ill-defined, bent, becoming oblique inwards, with some black marking near costa; median shade also ill-defined (especially in anterior half), strongly sinuous, the proximal curve in submedian area being rather deep; postmedian line well expressed, from a black spot at two-thirds costa to one at about three-fourths hind margin, forming a slight outward curve from SC⁵ to M² and a stronger submedian inward curve, marked throughout with small dark dashes on the veins; some broad, vague, irregular dark shading between this and termen; fringe with large black spots opposite the veins. Hind wing with termen somewhat sinuate towards tornus; M¹ separate at its origin from R³; concolorous with fore wing, the median

and postmedian lines strongly expressed; distal area and fringe as on fore wing. Under surface paler; fore wing very weakly marked, only the postmedian line showing, and that faintly; hind wing with median and postmedian lines, though much weaker than above; fringes with the dark spots present, but weaker than above.

1909: Jan. 13,—1 ♂ (type).

In some respects similar to *Pt. semilinea* Warr. (Nov. Zool. iii. p. 314), from the Khasia Hills. Remarkable for the subcostal venation of the fore wing, which is like that of *Chrysocraspeda* and almost unique in *Ptychopoda*; I know of only one species which shares the peculiarity, namely *marginata* Swinh. (Tr. Ent. Soc. Lond. 1894, p. 182), unless *chrysocilia* Hmps. (Ill. Het. viii. p. 124) is also a *Ptychopoda*; in any case none of the three has any connection with *Chrysocraspeda*, which has strongly pectinate male antenna, hind tibia with four spurs, cell of hind wing short, etc.

Subfam. LARENTINÆ.

PSEUDOSTERRHA PHILÆARIA (Brabant).

Sterrha philæaria Brabant, Bull. Soc. Ent. Fr. 1896, p. 384.

Pseudosterrha gayneri N. Rthschd. Nov. Zool. viii. p. 433 (1901); xii. t. 4. fig. 10 (1905).

1908: Sept. 16,—1 ♀.

Described from Egypt. I suspect, however, it is merely a form of—or even entirely synonymous with—*Ps. paullula* Swinh. (Proc. Zool. Soc. Lond. 1886, p. 456), from India.

EUPHYIA (CAMPTOGRAMMA) NATALATA (Walk.).

Scotosia natalata Walk. List Lep. Ins. Brit. Mus. xxv. p. 1681 (1862).

Scotosia rubritincta Hmps. Bull. Liverp. Mus. ii. p. 38 (1899).

Hargaisa.—1908: Oct.—1 ♂.

Widely distributed in East Africa, also Socotra.

Subfam. GEOMETRINÆ.

HETEROSTEGANE INDULARIA (Guen.).

Stegania indularia Guen. Spec. Gén. Léop. x. p. 46 (1858).

Mandera.—1908: Apr. 27,—1 ♂; May 2,—1 ♀; May 28,—1 ♀; June 1,—2 ♂, 4 ♀; June 18,—1 ♂; June 29,—2 ♂; July 8,—1 ♂; July 17,—1 ♂; July 24,—1 ♂; July 31,—1 ♂; Sept. 13,—3 ♂, 1 ♀; Sept. 14,—1 ♂; Sept. 17,—2 ♂; Sept. 22,—1 ♂; Sept. 24, 4 ♂, 1 ♀; Sept. 26,—2 ♂, 1 ♀; Oct. 1,—1 ♂. 1909: Mar. 24,—1 ♀; Apr. 8,—1 ♂; May 10,—1 ♀. 1910: Mar. 2,—1 ♀.

Hargaisa.—1908: Oct.—1 ♂.

The series from Mandera shows the usual range of variation in ground-colour and intensity of markings, but nearly all are of small size.

The male from Hargaisa may perhaps be referred to *ab. calidata* Warr. (Nov. Zool. iv. p. 78), though the ground-colour remains pale; all three lines are strongly developed; possibly a distinct species, as the palpus looks a little stronger and the antennæ (unfortunately damaged) may have less long ciliation.

Described from Abyssinia, but extends through eastern Africa to the Cape.

ZAMARADA SECUTARIA (Guen.).

Stegania secutaria Guen. Spec. Gén. Léop. x. p. 45 (1858).

Zamarada pulverosa Warr. Nov. Zool. ii. p. 158 (1895).

Mandera.—1908: Sept. 23,—1 ♂.

Hargaisa.—1908: Oct.,—1 ♂.

Both are small, the Hargaisa example rather worn, but apparently more weakly dusted than usual.

This species is likewise distributed from Abyssinia to the Cape.

OSTEODES PROCIDATA Guen., subsp. **ERITREËNSIS** Prout.

Osteodes procidata Guen. Spec. Gén. Léop. x. p. 177 (1858).

Osteodes turbulentata Guen. *ibid.* (1858).

Aspilates semispurcata Walk. List Lep. Ins. Brit. Mus. xxvi. p. 1679 (1862).

Gan Libbah.—1908: June 24,—1 ♂. 1909: Nov. 4,—1 ♀.

Both with the dark borders strong (subsp. *eritreënsis* Prout, Nov. Zool. xxii. p. 348, described from Eritrea).

Distribution as in the two preceding. Warren (Nov. Zool. ix. p. 529) apparently regarded Guenée's two forms (from Abyssinia and the Cape) as separate species, but Guenée's descriptions and the material before me suggest that Swinhoe (Tr. Ent. Soc. Lond. 1904, p. 504) is correct in uniting them.

D-SCALMA SUBCURVARIA (Mab.).

Tephрина subcurvaria Mab. Ann. Soc. Ent. Fr. lxvi. p. 278 (1897).

Hargaisa.—1908: Oct.,—1 ♂.

This species, apparently common throughout East Africa from Abyssinia to Natal, and originally described as from West Africa, has been mixed in our British collections with *observata* Walk. (List Lep. Ins. xxiii. p. 963) from the Cape, but I doubt the correctness of this; the latter, apart from its much darker and rather more reddish colour, has the median shade of the fore wing more oblique and the postmedian line rather further from the termen.

DISCALMA PUERILIS, sp. n. (Pl. II. fig. 15, ♂.)

♂, 16 mm. Face apparently without projecting cone of scales. Antennal joints scarcely projecting, the cilia scarcely as long as diameter of shaft. Head, body, and legs concolorous with wings; hind tibia dilated, with long hair-pencil, tarsus rather short.

Fore wing with fovea slight, SC^{1-2} coincident, touching C at a point; dirty white irrorated with brown-grey, leaving clearer a slight, ill-defined antemedian band (at least towards hind margin), a fairly broad but exceedingly ill-defined band just distally to the cell-dot and especially a broad, somewhat sinuous subterminal line, from costa at less than 1 mm. before apex to tornus, slightly dark-shaded proximally, especially at costa and hind margin; a small discal dot near costa at middle; a slightly darkened terminal line, interrupted at the veins; fringe pale (whitest proximally), traversed in middle by a fine grey line and cut throughout its length by brown-grey spots opposite the veins. Hind wing with termen almost smooth (scarcely waved); similar to fore wing, but with pale band-like markings scarcely indicated, subterminal line not quite so conspicuous as on fore wing; no discal dot; indications of a dark spot (end of a line) about middle of inner margin. Under surface similarly but more faintly marked; discal dot of fore wing absent.

1910: Feb. 14,—1 ♂ (type).

A very distinct though modest little species; it may be pictured by imagining a miniature edition of the North American "*Sciagraphia*" *nubiculata* Pack., exceedingly washed-out, dark lines of hind wing absent; structure as in that species, wings slightly narrower.

DISCALMA CALVIFRONS, sp. n. (Pl. II. fig. 14, ♂.)

♂, 17–20 mm. Face rather protuberant, rough, almost scaleless, with small horny prominences at upper and again at lower edge. Palpus rather short, rough-scaled, grey mixed with fuscous, 3rd joint very small and blunt. Antenna with joints projecting, the ciliation about as long as diameter of shaft, arranged in very slender even fascicles. Thorax and abdomen concolorous with wings, the patagia in front more fuscous. Hind tibia with hair-pencil. Fore wing with fovea; not broad, the termen being rather straight and moderately strongly oblique; SC^{1-2} coincident, sometimes free, sometimes slightly connected or anastomosing at a point with one or both of the adjacent veins; white-grey, irrorated with brownish fuscous; discal dot black, variable in size; lines fuscous, irrorated more or less with blackish, sometimes sharply dark at costa; antemedian from nearly one-fourth costa, oblique outwards, strongly angled in front of M, then oblique inwards to M, here sometimes marked with a blackish dot, then running perpendicularly to hind margin, occasionally with a very slight curve inwards; median line very variable in strength and thickness, usually crossing, sometimes just proximal to, the discal dot, almost straight except for a small proximal bend at costa; postmedian from before three-fourths costa, vertical or (oftener) slightly oblique outwards, curved or angled at R^1 , thence about parallel with termen, marked with blackish vein-dots, sinuate inwards in submedian area and slightly oblique outwards at hind margin; distal area (at least in its proximal half) clouded with

dark grey, with a distinct, sinuous, whitish, subterminal line, which is rather thick in places, and especially widens at costa so as almost to reach apex; proximally to the subterminal an irregular blackish spot between R^3 and M^1 , sometimes also anteriorly to R^3 ; termen with a row of moderately thick blackish dashes; fringe weakly dark-chequered opposite the veins. Hind wing with termen almost perfectly rounded, sometimes with a slight suggestion of prominence at R^3 and sinuosity in front of the same; similar to fore wing, without the antemedian line. Fore wing beneath somewhat more suffused from base to median shade; discal dot weak; the shade between postmedian and subterminal strengthened into a dark band, without the blackish spot, the subterminal itself obsolete; band between median and postmedian lines, also the posterior half of distal area (or at least a patch behind R^3) somewhat whiter than above. Hind wing beneath whitish, with median shade, discal dot and outer band distinct. Female, on an average, rather larger, rather broader-winged, sometimes more suffused, lines generally weak (except the costal spots), distal dark shade extended to termen, usually almost obliterating the subterminal line except costally, where the subapical pale spot persists, at least in part, black spot proximally to subterminal line between R^3 and M^1 seldom developed; the hind wing and under surface show corresponding differences.

1908: Sept. 14,—1 ♂; Sept. 24,—1 ♂; Sept. 28,—1 ♂; Oct. 14,—1 ♀; Oct. 15,—1 ♂; Oct. 24,—1 ♂ (type). **1909:** Apr. 10,—2 ♀; Apr. 14,—1 ♂; Apr. 22,—1 ♀; Apr. 27,—1 ♀; May 10,—1 ♀; May 12,—1 ♀.

Variable both individually and (in particular) sexually. More recalls certain tropical American species (e. g. *Macaria nigricomma* Warr. in the case of the male, *heliothidata* Guen. in that of the female) than any African species with which I can compare it. Scarcely a true *Discalma*.

MACARIA SEMIALBIDA Prout.

Macaria semialbida Prout, Nov. Zool. xxii. p. 351 (1915).

1908: June 21,—1 ♂.

Antenna broken, but a remnant shows that the ciliation is scarcely as long as the diameter of the shaft. Hind tibia strongly dilated. Fovea strong.

Founded on females from British East Africa.

MACARIA OBLIQUILINEATA (Warr.).

Gonodela obliquilineata Warr. Nov. Zool. vi. p. 307 (1899).

Semiothisa obliquilineata Swinh. Tr. Ent. Soc. Lond. 1904, p. 507.

1908: May 4,—2 ♀. **1909:** Mar. 14,—1 ♂; Apr. 11,—1 ♀; May 10,—1 ♀; Nov. 10,—1 ♀.

Rather variable, on an average slightly smaller than the

examples (Abyssinia, White Nile, British East Africa) in the British Museum, postmedian line of fore wing rather more curved at costa. In the fore wing veins SC^{1-2} are coincident, in three examples free, in three slightly connected with C.

TEPHRINA INCONSPICUA Warr.

Tephрина inconspicua Warr. Nov. Zool. iv. p. 113 (1897).

1908: July 2,—1 ♀; Aug. 24,—1 ♀.

Rather weakly marked, especially the hind wing, which appears rather more whitish than in the normal form (Natal to Nyassaland); but it is not in quite perfect condition. In the fore wing the costal end of vein C is obsolete, leaving it to appear that C and SC^1 are coincident throughout, anastomosing shortly with SC^2 . A worn female from Arabia (coll. Brit. Mus.) appears to agree with the Somaliland example, though larger and with normal venation; thus the species seems to be widely distributed.

TEPHRINA BUTARIA (Swinh.).

Semiothisa butaria Swinh. Tr. Ent. Soc. Lond. 1904, p. 510.

1909: May 8,—1 ♂.

Known from Central and East Africa and as far north as Abyssinia.

TEPHRINA NETTA (Holland).

Grammodes netta Holland, in Donaldson-Smith, Through Unknown African Countries, p. 418, fig. 9 (1897).

1908: July 1,—1 ♂; July 31,—1 ♀; Sept. 21,—1 ♀; Sept. 26,—1 ♀. 1909: May 21,—1 ♀; July 8,—1 ♀; Aug. 17,—1 ♂.

As I understand Sir George Hampson has compared Holland's type, I accept the determination of the species at the British Museum, which possesses a single example from Abyssinia. The fore wing agrees well with Holland's figure, but the hind wing has distal borders nearly as in *Discalma subcurvaria* Mab., or even more extended to the termen. Male antenna bipectinate.

TEPHRINA CINERASCENS (Btlr.).

Acidalia cinerascens Btlr. Ann. Mag. Nat. Hist. (4) xvi. p. 418 (1875).

Ematurga bilineata Warr. Nov. Zool. ii. p. 129 (1895).

Tephрина cinerascens Swinh. Tr. Ent. Soc. Lond. 1904, p. 511.

1909: May 10,—1 ♀. Rather worn, weakly marked.

Distributed from the Cape to British East Africa, and doubtfully distinct from *pumicaria* Led. (Syria) and *fumosa* Hmps. (India). The large, strongly marked Abyssinian form figured by Guenée (Phal. t. 17. fig. 7) is unknown to me.

TEPHRINA DISPUTARIA (Guen.).

Eubolia disputaria Guen. Spec. Gén. Léop. x. p. 489 (1858).

Tephрина disputaria Hmps. Faun. Ind., Moths, iii. p. 209 (1895).

Mandera. 1908: June 1, -1 ♀; June 29, -1 ♀; July 5, 1 ♀; July 17, -1 ♀; Aug. 24, -3 ♀; Sept. 13, -1 ♀; Sept. 19, 1 ♀; Sept. 26, -1 ♂, 1 ♀; Oct. 12, -1 ♀. 1909: Jan. 18, -1 ♀; Jan. 19, -1 ♀; Mar. 12, -1 ♀; Mar. 19, -1 ♀; Apr. 7, -1 ♀; Apr. 22, -1 ♀; Aug. 17, -1 ♂, 2 ♀; Oct. 5, -1 ♀; Nov. 9, -2 ♀. 1910: Mar. 2, -1 ♀; Mar. 6, -1 ♀. Year?: Feb. 25, -1 ♀.

Hargaisa.—1908: Oct., -4 ♂.

Extremely variable, occurring probably throughout the year, though none was taken in February or December. The great majority of the females belong to the form *subocellata* Warr. (Nov. Zool. iii. p. 413), described from S. Othman, Arabia. I follow Swinhoe in considering *subocellata* to be a form of the variable *disputaria* Guen. Two of the males are small, with the distal part of the median area almost free from dark dusting, the postmedian line more than usually bent. A few females are also small, but otherwise normal. Two females are smooth-scaled, the distal area broad, inclining to violet-grey, the black marks on hind margin of fore wing and those distally to the middle of the postmedian line very sharply prominent.

Described from Egypt, but widely distributed in North and East Africa, Arabia, India, etc.

TEPHIRINA DEERRARIA Walk.

Tephirina deerraria Walk. List Lep. Ins. Brit. Mus. xxiii. p. 962 (1861); Swinh. Tr. Ent. Soc. Lond. 1904, p. 510.

Mandera.—1908: Oct. 15, -1 ♀. 1909: Apr. 7, -1 ♀; Apr. 10, 1 ♀; Apr. 22, -1 ♀; May 10, -1 ♀; Oct. 7, -1 ♂; Oct. 11, 1 ♂. 1910: Jan. 8, -1 ♀.

Buggan.—1908: June 27, -1 ♂.

In one female the discal spot of the fore wing is reduced, scarcely forming an ocellus. Generally larger than the preceding, less brown, postmedian line straighter, otherwise hard to distinguish; perhaps a form of the same. Distributed from the Cape to Abyssinia.

TEPHIRINA PRIONOGYNA, sp. n. (Pl. II. fig. 13, ♀.)

♀, 28–33 mm. Antenna strongly serrate, the serrations of the outer series so long as to form rudimentary pectinations. Fore wing with SC^1 out of C , free or anastomosing at a point with SC^2 , SC^2 in one example anastomosing at a point with SC^{3+4} . Otherwise extremely like strongly irrorated females of the preceding*; discal mark of fore wing reduced to a small weak dot, median shade usually absent, antemedian line of fore wing more strongly curved, postmedian curving anteriorly (both variable in distinctness), terminal dots weaker or obsolete, the dark distal border beneath extended to the termen, or else becoming

* In *disputaria* and *deerraria* SC^{1+2} are coincident, often anastomosing at a point or slightly connected with SC^{3+4} . Even if this difference prove not absolutely constant, it is at least general.

uniformly lighter there, no tendency towards the *central* pale terminal patches which are general in *deerraria*, termen of hind wing smooth (in *disputaria* often slightly more undulate).

1909: Apr. 15,—1 ♀; May 9,—1 ♀; May 10,—3 ♀ (including type).

CENINA TERGIMACULA, sp. n. (Pl. II. fig. 12, ♂.)

♂ ♀, 24 mm. Face ochreous, lower half with a large fuscous spot on each side. Palpus with 3rd joint short, ochreous mixed with fuscous. Male antennal pectinations long and reaching to near apex—beyond three-fourths (female without head). Vertex, thorax, and abdomen concolorous with wings, abdomen with a dark fuscous dorsal blotch anteriorly. Fore wing narrow, costa and termen almost straight, hind margin somewhat convex, in female sinuous; SC^2 connected by bar with SC^{3+4} , R^3-M^1 stalked (sometimes rather long-stalked); pale ochreous whitish, irrorated and suffused, especially at base and half-way along costa, with purple-grey; a brown or fuscous stripe from beyond middle of costa, oblique outwards, strongly curved or angled between R^1 and R^2 , oblique inwards (and forming a very slight proximal curve) to middle of hind margin; a faint, oblique antemedian line or shade usually indicated, another midway between postmedian and termen, bearing in its anterior part two or three darker wedge-shaped spots, the one before R^1 the strongest and blackest; fringe spotted with fuscous. Hind wing narrow, especially in female, tooth at end of SC^2 in female very acute and produced, termen in male weakly, in female more strongly, toothed at R^3 , anal angle scarcely produced; concolorous with fore wing or rather more brightly and sharply marked; a broad, dark, olive-brown, fuscous-mixed, somewhat sinuous band from inner margin near anal angle to costa near apex, finely white-edged distally, the white broadening anteriorly. Under surface similar, the markings weaker and more diffuse.

1908: Oct. 3,—1 ♂. 1909: Apr. 7,—1 ♂; Apr. 12,—1 ♂ (type); Sept.—1 ♀.

Genus *SESQUIALTERA*, nov.

Face slightly prominent, convex, with moderately appressed scales. Palpus moderate, rather stout, rough-scaled, terminal joint short. Tongue short. Antenna in male (?); in female slightly subserrate, with very minute ciliation. Pectus and femora moderately hairy. Hind tibia with terminal spurs only. Fore wing long and narrow (greatest breadth—mid-costa to tornus—three-eighths of length), costa nearly straight, apex rather sharp, termen, except close to apex, extremely oblique, slightly curved, very faintly sinuous, rather longer than hind margin; tornus very weak; cell short, less so at its extremities, DC^2 being oblique inwards and DC^3 extremely oblique outwards; SC^{1-2} long-stalked, SC^3 sometimes anastomosing with C, SC^2 connected by a

bar with SC^{3-4} about opposite the origin of SC^5 , SC^{3-5} long-stalked from just before end of cell, SC^{3-4} separating near apex; radials normal; M^1 long-stalked with R^3 , M^2 arising rather near end of cell. Hind wing only about half the length of fore wing, costal margin strongly concave, termen with long projecting teeth at SC^2 and R^1 , otherwise sinuous rather than dentate, tornus moderate; cell about one-half, DC incurved; C approximated (but not appressed) to SC to near end of cell, then moderately diverging; SC^2 from close to end of cell; R^2 absent; R^3-M^1 long-stalked, M^2 from very near end of cell.

Type of the genus: *Sesquialtera ridicula*, sp. n.

SESQUIALTERA RIDICULA, sp. n. (Pl. II. fig. 11, ♀.)

♀, 32–36 mm. Head, body, and fore wing fuscous with darker irroration. Fore wing extremely weakly marked, a darker cell-mark and a postmedian line indicated, the latter remote from termen, strongly excurved at radials; sometimes also a vague, diffuse, oblique, somewhat curved antemedian line or shade indicated. Hind wing variable, in the type with the basal area blackish fuscous, the rest more concolorous with fore wing, but traversed by ill-defined ferruginous-brown bands, in other examples more uniform, the base being less blackened, the ferruginous scales largely suppressed; a blackish discal dot, crossed or closely preceded by the more or less sinuous antemedian (median) line and followed by a distinct postmedian (darker brown or blackish) sinuate inwards between radials and in submedian area; a brown or black terminal line. Under surface similar to upper, in the type less variegated in hind wing.

1909: May 12,—1 ♀ (type).

Also in Hope Department, Oxford, from British East Africa, 5 May, 1913, c. 1° S., 35° E., 5000–6000 feet, forest with open glades (*H. B. Popplewell*), 1 ♀. Also from Mt. Kenya in Paris Museum.

PACHYPALPIA SUBALBATA Warr.

Pachypalpia subalbata Warr. Nov. Zool. vii. p. 98 (1900).

1908: Oct. 25,—1 ♀.

Described from British East Africa. Known also from German East Africa.

ASCOTIS SELENARIA (Schiff.).

Phalcena Geometra selenaria [Schiff.] Schmett. Wien, p. 101 (1775).

Ascotis selenaria Hbn. Verz. Bek. Schmett. p. 313 (1826).

Trigonomelea semifusca Warr. Nov. Zool. xi. p. 475 (1904).

1909: May 10,—1 ♂.

Extraordinarily widely distributed in S. and E. Europe, Asia, and Africa.

Fam. SATURNIDÆ.

EPIPHORA ATBARINUS Butl.

1909: Oct. 14,—1 ♂, 2 ♀.

LUDIA HANSALI Feld.

1908: Oct. 29,—1 ♀. 1909: Sept.,—1 ♀. Year?: Apr. 27,
—1 ♂ (B.M.).

Fam. ARBELIDÆ.

SELAGENA EUSTRIGATA, sp. n. (Pl. II. fig. 27, ♂.)

♂. Head and thorax white tinged with rufous, the dorsum of thorax with long spatulate chocolate-brown scales; antennæ with the branches rufous; pectus and legs white, the latter with brown mixed; abdomen white, the 2nd segment with dorsal tuft of long spatulate rufous and chocolate-brown scales, the anal tuft tinged with rufous and with spatulate black-brown scales mixed. Fore wing creamy white, with fine dark brown pencillings with white bars on them defined by black and leaving the veins white below base of costa, from medial part of cell to inner margin, in end of cell, between veins 5 and 2 to near termen, and forming a wedge-shaped subterminal patch between veins 8 and 6; a white patch with some rufous before and beyond it beyond the discocellulars, and a white spot with some rufous before and beyond it below vein 2 near its origin. Hind wing silvery white. Underside white; fore wing with the cell and area beyond it to near termen suffused with brown with some white striæ on it; hind wing with some red-brown striæ on medial part of costa.

1908: Sept. 13,—1 ♂ (type); Sept. 14,—1 ♂ (B.M.); Sept. 18,—1 ♂; Sept. 20,—1 ♂; Sept. 26,—1 ♂; Oct. 6,—1 ♂.
1909: Sept.,—2 ♂. *Exp.* 20–24 millim.

SELAGENA ATRIDISCATA Hmpsn.

1909: Oct. 5,—1 ♀.

METARBELA DIODONTA, sp. n. (Pl. II. fig. 28, ♂.)

♂. Head and thorax dark reddish brown mixed with some grey-white, the frons whiter; palpi black-brown; pectus and legs red-brown mixed with some whitish; abdomen white tinged with brown and with chocolate-brown dorsal streaks at base and extremity, the anal tuft tipped with chocolate-brown. Fore wing white tinged with brown; a series of black-brown points below the costa; a black-brown subbasal point on median nervure with a slight dentate dark brown line from beyond it to inner margin; a very irregular patch of brown suffusion defined by black-brown on medial part of inner margin, indented above and below by white spots towards its extremity; a down-curved black-brown streak from middle of cell to lower angle with a point beyond it in the cell and an irregular oblique bilobate mark defined by black-brown in upper extremity of cell; an oblique strongly

dentate dark line from below apex to inner margin at the medial patch with more prominent blackish teeth between veins 7 and 5 and some dark suffusion beyond it; a terminal series of geminate black points. Hind wing silvery white with a very faint brownish tinge and faint brownish terminal line. Underside white with a faint brownish tinge and series of small brown spots on costa of fore wing.

♀. Abdomen more suffused with brown; fore wing more suffused with brown, the streak in lower end of cell absent and the oblique dentate postmedial line very indistinct; hind wing strongly tinged with brown.

1908: Sept. 27,—1 ♂; Sept. 28,—1 ♂; Sept. 29,—1 ♂; Oct. 1,—1 ♂; Oct. 4,—1 ♀ (type); Oct. 11,—1 ♂ (type); Oct. 14,—1 ♂ (B.M.); Oct. 20,—1 ♂; Oct. 23,—1 ♂; Oct. 24,—1 ♂.
1909: Sept.—1 ♂. *Exp.* 22–26 millim.

METARBELA PERSTRIATA, sp. n. (Pl. II. fig. 29, ♀.)

♀. Head, thorax, and abdomen grey-white suffused with reddish brown. Fore wing creamy white, thickly irrorated with dark reddish brown and with numerous rather reticulate lines, formed by dark reddish-brown striæ and with obscure dark brown spots at middle and end of cell. Hind wing and underside whitish suffused with brown.

1908: Sept. 27,—1 ♀ (type). *Exp.* 22 millim.

ARBELODES RUFULA Hmps. n.

1909: Mar. 14,—1 ♂; Apr. 8,—1 ♂; May 10,—1 ♂.

Fam. COSSIDÆ.

AZYGOPHLEPS INCLUSA Wlk.

1909: May 13,—1 ♀.

DUOMITUS MESOSTICTA, sp. n. (Pl. II. fig. 30, ♂.)

♂. Head, thorax, and abdomen white mixed with dark brown, the metathorax almost entirely black-brown; palpi and tarsi black-brown. Fore wing white irrorated with reddish brown, the medial inner area with a shade formed by thicker irroration, extending before middle to above vein 1; a discoidal patch formed by similar irroration conjoined beyond lower angle of cell to a similar shade on terminal area, the cell, submedian interspace except on terminal area, and an oblique postmedial shade from costa whiter; elliptical black-brown medial spots above and below vein 1; cilia chequered dark brown and white at tips. Hind wing white, the cilia chequered with dark brown to vein 2. Underside of fore wing with the inner area white with a brown spot below middle of cell; hind wing with the costal area irrorated with brown.

1908: Apr. 29,—1 ♂; May 4,—1 ♂ (B.M.); Sept. 12,—1 ♂.

1909: Oct. 7,—1 ♂ (type). *Exp.* 28–38 millim.

DUOMITUS STENIPTERA, sp. n. (Pl. II. fig. 31, ♂.)

♂. Head and thorax white mixed with red-brown and some black, the metathorax almost entirely black-brown; antennæ dark brown; tarsi black ringed with white; abdomen whitish suffused and irrorated with red-brown. Fore wing white with sparse strong black striae, the inner area tinged with rufous to beyond middle; a wedge-shaped black-brown patch on costal area from base to near middle; a rather triangular black spot below end of cell with its upper extremity somewhat produced; a black-brown patch at end of cell extending to the costa; some small black spots on costa towards apex; a subterminal series of small more or less distinct clavate dark marks in the interspaces; cilia chequered reddish brown and white. Hind wing white, the cilia with some brown scales mixed. Underside white; fore wing with small black spots on costa and blackish spot below end of cell, the terminal area striated with brown; hind wing with the costal area finely striated with red-brown.

1908: Apr. 27,—1 ♂ (type). 1909: May,—1 ♂. *Exp.* 28–38 millim.

DUOMITUS SIMILLIMA, sp. n. (Pl. II. fig. 32, ♂.)

♂. Head and thorax dark red-brown mixed with some whitish and black, the metathorax entirely black-brown; antennæ dark brown; tarsi black ringed with white; abdomen dark red-brown mixed with whitish at sides towards base. Fore wing grey-white suffused with red-brown and sparsely striated with strong black striae, slighter on basal area, the medial area from costa to vein 1, the postmedial area from costa to vein 2, and the interspaces of terminal area whiter; a rather triangular black spot below the cell; subterminal series of slight clavate dark marks in the interspaces; cilia chequered dark brown and greyish. Hind wing whitish suffused with brown, the cilia obscurely chequered with dark brown. Underside of fore wing suffused with brown, the terminal area striated with brown, series of small black spots on costa and below terminal part of cell; hind wing whitish, the costal area suffused with brown, the costa towards apex and termen with some brown striae.

1908: Sept. 20,—1 ♂ (type); Sept. 23,—1 ♂. *Exp.* 24–28 millim.

Fam. LASIOCAMPIDÆ.

TRICHIURA OBSOLETA Klug.

1908: Oct. 25,—1 ♂; Oct. 29,—1 ♂. 1909: Mar. 14,—2 ♂; Apr. 8,—2 ♂; Apr. 11,—1 ♀; Apr. 15,—1 ♀; Oct. 14,—1 ♂, 1 ♀; Dec. 30, 1 ♂. 1910: Jan. 2,—1 ♂; Mar. 10,—1 ♀; Mar. 13,—1 ♂.

ANADIASA SIMPLEX Pag.

1909: Apr. 8,—1 ♂.

CHILENA DONALDSONI Holl.

1908: Oct. 13,—1 ♂. 1909: Feb. 20,—1 ♂; Mar. 26,—1 ♂; Mar. 29,—1 ♂; Apr. 1,—1 ♂; Apr. 5,—1 ♂; Apr. 6,—1 ♀; Apr. 10,—4 ♂; Apr. 14,—1 ♂; Apr. 20,—1 ♂. 1910: Mar. 20,—1 ♂.

Fam. LIMACODIDÆ.

CÆNOBASIS CHLORONOTON, sp. n. (Pl. II. fig. 35, ♂.)

♂. Head and thorax emerald-green; antennæ fulvous yellow; palpi fulvous yellow, brownish at sides; tibiæ on inner side and the tarsi fulvous yellow, the tarsi with brown points on outer side; abdomen pale orange-yellow, the sides and ventral surface whitish at base. Fore wing emerald-green, the costal edge orange-yellow. Hind wing white tinged with emerald-green, especially towards termen; the cilia emerald-green. Underside of fore wing with the costal half fulvous brown, the inner half greenish white, the termen and cilia green; hind wing pale orange-yellow, the terminal area tinged with green; the cilia green.

1908: Oct. 12,—1 ♂. 1909: Apr. 4,—1 ♂ (type); Apr. 8,—2 ♂ (1 in B.M.); Apr. 9,—1 ♂; Apr. 10,—1 ♂; Apr. 20,—1 ♂; Apr. 23,—1 ♂; Apr. 24,—1 ♂ (B.M.); Sept.—1 ♂. *Exp.* 18–20 millim.

CÆNOBASIS FULVICORPUS Hmps.

1908: Sept. 26,—1 ♂; Oct. 24,—1 ♂. 1909: Apr. 4,—1 ♂; Apr. 5,—1 ♂; Apr. 7,—3 ♂; Apr. 8,—2 ♂, 1 ♀.

Genus FEATHERIA, nov.

Type, *F. obvia*.

Proboscis absent; palpi obliquely upturned, short, not reaching to middle of frons, which is smooth; antennæ of male bipectinate with moderate branches to apex, of female with short branches; metathorax with spreading crest; tibiæ with the spurs moderate, the hind tibiæ with the medial spurs present; abdomen with rough hair at base of dorsum. Fore wing with the apex rounded, the termen evenly curved; veins 2, 3 shortly stalked, 5 from near angle; 6 from well below upper angle; 7 from just below angle; 8, 9 stalked; 10, 11 from cell. Hind wing with veins 3 and 5 from near angle of cell; 6, 7 stalked; 8 from middle of cell.

FEATHERIA OBVIA, sp. n. (Pl. II. fig. 33, ♂.)

♂ ♀. Head and thorax grey-white mixed with reddish brown; tarsi ringed with white; abdomen grey-white tinged with red-brown. Fore wing grey-white tinged in parts with reddish brown and irrorated with dark brown; a dark brown point at lower angle of cell, with an oblique brown line from it to inner margin slightly defined on outer side by whitish followed by a reddish-brown shade; an oblique dark-brown fascia from apex meeting the shade beyond the medial line, slightly incurved below vein 7,

where there is a more or less elongate black spot beyond it, the oblique fascia followed by a whitish shade arising below apex; a terminal series of black-brown striæ. Hind wing white suffused with reddish brown; a fine darker brown terminal line and fine white line at base of cilia. Underside white tinged with reddish brown, the costal areas irrorated with brown.

Mandera.—1903: July 16,—1 ♂; Aug. 16,—1 ♂; Sept. 26,—2 ♂, 1 ♀; Sept. 27,—1 ♀ (type). 1909: Mar. 24,—1 ♂ (type); Apr. 9,—1 ♂; Sept. 6,—1 ♀.

Gan Libbah.—1908: June 26,—1 ♀. *Exp.* ♂ 22, ♀ 28 millim.

PARYPHANTA FIMBRIATA Karsch (ARCULINEA B.-B.).

1909: Mar. 26,—1 ♂; Apr. 10,—1 ♂.

SCOTINOCHROA MINOR, sp. n. (Pl. II. fig. 34, ♂.)

♂. Head, thorax, and abdomen bright chestnut mixed with fulvous yellow and some dark brown; antennæ fulvous. Fore wing bright chestnut irrorated with dark brown and rough silvery scales; an obscure dark mark below origin of vein 2; the postmedial area ochreous whitish with a very ill-defined band of dark and silvery scales, rather maculate to lower angle of cell, then excurved; a curved maculate subterminal band of dark and silvery scales from below costa to vein 2; a dark brown patch at apex. Hind wing yellow tinged with rufous, the cilia deeper rufous at tips. Underside yellow, the fore wing suffused with rufous, the hind wing tinged with rufous.

1909: Apr. 20,—1 ♂ (type). *Exp.* 18 millim.

GAVARA LEUCOMERA, sp. n. (Pl. II. fig. 36, ♀.)

♀. Head, thorax, and abdomen white, faintly tinged with rufous; fore tibiæ and the tarsi pale brown ringed with white. Fore wing white tinged with rufous except on terminal area, which is slightly irrorated with rufous; a rather oblique rufous antemedial shade from below costa to inner margin; a black point at lower angle of cell; an indistinct waved rufous line from lower angle of cell to inner margin; an indistinct sinuous rufous line from middle of costa to submedian fold above tornus, then incurved to inner margin; a distinct diffused rufous line from costa beyond middle to termen at submedian fold, excurved at middle; a terminal series of rufous striæ. Hind wing white tinged with rufous; a fine rufous terminal line; cilia white. Underside white, the fore wing suffused with rufous, the hind wing tinged with rufous.

1909: Apr. 8,—1 ♀ (type). *Exp.* 16 millim.

Fam. THYRIDIDÆ.

RHODONEURA HAMATIPEX, sp. n. (Pl. II. fig. 37, ♂.)

♂. Head, thorax, and abdomen ochreous suffused with rufous. Fore wing ochreous tinged with rufous and thickly reticulated

with rufous striae, browner at costa; a slight antemedial line forking towards costa and forming a slight fork towards inner margin; a narrow rather oblique postmedial band formed by two lines filled in with rufous except towards costa, the inner line curved inwards to costa and somewhat angled inwards at lower angle of cell and vein 1, the outer line excurved below costa, the band somewhat constricted at submedian fold, a reticulate band formed of double striae beyond it from vein 7 to tornus; an oblique double line filled in with rufous across apical area from costa to termen at vein 4. Hind wing ochreous tinged with rufous and striated with rufous lines; a slightly curved antemedial line, dark point just above lower angle of cell, darker slightly sinuous medial line, two or three faint postmedial lines, and a more prominent subterminal line oblique to discal fold, then sinuous to tornus. Underside of fore wing with a streak formed by black spots and opalescent silvery scales below middle of cell and a short streak formed by black dashes beyond upper angle, the medial part of postmedial band, the subterminal band towards tornus, and the oblique band except at costa prominently filled in with rufous.

1909: Apr. 11,—1 ♂; Oct. 19,—1 ♂; Oct. 30,—1 ♂ (type).
Exp. 22 millim. Closely allied to *R. squamigera* Pag.

Fam. PYRALIDÆ.

Subfam. CRAMBINÆ.

ANCYLOLOMIA PECTINIFERA Hmps.

1909: Mar. 10,—1 ♀; Mar. 14,—1 ♀.

SURATTHA SCITULELLUS Wlk.

1908: Sept. 18,—1 ♀; Sept. 20,—1 ♀; Sept. 21,—1 ♀; Sept. 22,—1 ♀; Sept. 24,—2 ♀; Sept. 26,—1 ♀. **1909:** Mar. 13,—1 ♀; Mar. 14,—1 ♀ (B.M.); Mar. 19,—1 ♀; Mar. 22,—1 ♀.

SURATTHA INVECTELLUS Wlk.

1908: Aug. 15,—1 ♂; Sept. 14,—1 ♂; Sept. 20,—1 ♂; Sept. 24,—1 ♂; Sept. 26,—1 ♀. **1909:** Feb. 15,—1 ♀; Feb. 16,—2 ♀; Feb. 23,—1 ♂; Mar. 5,—1 ♂; Mar. 11,—1 ♀ (B.M.); Mar. 13,—3 ♂, 4 ♀; Mar. 19,—1 ♂, 1 ♀ (♂ B.M.); Oct. 14,—1 ♀.

Subfam. SCHENOBIANÆ.

Genus CALAMOSCHENA, nov.

Type, *C. ascriptalis*.

Proboscis absent; palpi upturned, in male hardly reaching to middle of frons, in female to vertex of head; maxillary palpi minute; frons smooth, rounded; antennæ in both sexes laminate and almost simple; hind tibiæ with the outer medial spur minute. Fore wing with vein 3 from before angle of cell; 4, 5 shortly

stalked; 6, 7, 8, 9 stalked; 10, 11 from cell. Hind wing with veins 3 and 5 from angle of cell, 4 absent; 8 anastomosing with 7.

CALAMOSCHENA ASCRIPTALIS, sp. n. (Pl. II. fig. 38, ♂.)

♂. Head and thorax pale ochreous; pectus, legs, and abdomen ochreous white. Fore wing uniform pale ochreous. Hind wing glossy white, the cilia tinged with ochreous at base. Underside white; fore wing with the costal half tinged with ochreous.

♀. Head and thorax slightly tinged with rufous; abdomen more ochreous; hind wing with the termen and cilia at base tinged with ochreous.

1908: Oct. 6,—1 ♂ (type). 1909: Oct. 12,—1 ♀ (type).
Exp. ♂ 20, ♀ 28 millim.

Subfam. PHYCITINÆ.

STAUDINGERIA SUB-OBLITELLA Rag.

1909: Feb. 15,—1 ♀.

EUZOPHERA VILLORA Feld. (*STRAMANTELLA* Rag.).

1909: June 10,—1 ♀.

NEPHOPTERYX METAMELANA Hmps. n.

1908: Sept. 16,—1 ♀; Sept. 18,—1 ♂.

NEPHOPTERYX? *EMUSSATATELLA* Rag.

1908: Sept. 14,—1 ♀.

NEPHOPTERYX EUGRAPHELLA Rag.

1909: Oct. 11,—1 ♀.

NEPHOPTERYX SERRATELLA Rag.

1908: Feb. 24,—1 ♀; Sept. 12,—1 ♀; Sept. 19,—1 ♀ (B.M.); Sept. 26,—1 ♀ (B.M.); Oct. 12,—1 ♀; Oct. 20,—1 ♀; Oct. 25,—1 ♂ (B.M.); Nov. 18,—1 ♀. 1909: Jan. 9,—1 ♀ (B.M.); Mar. 13,—1 ♀; Apr. 16,—1 ♀ (B.M.); Dec. 31,—1 ♀.

Subfam. EPIPASCHIANÆ.

MACALLA PURPUREOPICTA, sp. n. (Pl. II. fig. 39, ♀.)

♀. Head and thorax pale grey; pectus, legs, and abdomen cupreous rufous, the last with some blackish at base of dorsum. Fore wing with large tufts of raised hair-like scales below the cell before middle and in middle and end of cell; pale greyish and white and with some dark irroration beyond the cell, the area below the cell and vein 3 purplish rufous from before middle to tornus; a blackish antemedial line from cell to inner margin, slightly angled outwards at submedian fold, the tufts of scales in the cell grey-brown; blackish streaks on middle of

vein 1 and basal half of veins 2 and 3, and a slight streak beyond upper angle of cell; an oblique black bar from origin of vein 7 to vein 5 near termen; a purplish-rufous patch on terminal part of costa with oblique purplish-rufous bar from it at vein 7 to vein 5 just before termen; a terminal series of dark striæ except towards tornus; cilia white tinged with rufous and with a pale brownish line near tips. Hind wing semihyaline white, the apical area suffused with red-brown to vein 4; a diffused purplish-red streak on terminal part of vein 2; a terminal series of red striæ, darker towards apex; cilia white, tinged with fiery red at base. Under-side of both wings white, the costal and apical areas red.

1909: Apr. 9,—1 ♀ (type). *Exp.* 24 millim.

Subfam. ENDOTRICHINÆ.

ENDOTRICHA CONSOBRINALIS Zell.

Hargaisa.—**1908:** Oct.,—2 ♂.

Subfam. PYRALINÆ.

AGLOSSA INCULTALIS Zell.

1909: Feb. 17,—1 ♂.

AGLOSSA OMMATALIS Hmps.

1909: Mar. 8,—1 ♀.

AGLOSSA BASALIS Wlk.

1908: Sept. 17,—1 ♀; Sept. 24,—1 ♀; Sept. 26,—1 ♀; Sept. 30,—1 ♀. **1909:** Feb. 11,—1 ♀.

TEGULIFERA ZONALIS Warren.

1908: Nov. 3,—1 ♀.

TEGULIFERA NIGRICINCTALIS Hmps.

1908: Sept. 18,—1 ♂; Oct. 1,—1 ♀; Oct. 13,—1 ♀. **1909:** Apr. 14,—1 ♀; Apr. 22,—1 ♂.

TYNDIS PROTEANALIS Hmps.

1908: Aug. 24,—1 ♀; Aug. 27,—2 ♂; Sept. 3,—1 ♂; Sept. 12,—1 ♀; Sept. 15,—1 ♂; Sept. 16,—1 ♂; Sept. 18,—1 ♂, 1 ♀; Sept. 19,—1 ♂; Sept. 21,—1 ♂, 1 ♀; Sept. 22,—1 ♀. **1909:** Mar. 9,—1 ♀; Mar. 10,—1 ♀; Mar. 11,—1 ♂; Mar. 12,—1 ♂; Mar. 15,—3 ♂, 1 ♀; Mar. 18,—2 ♀; Mar. 19,—3 ♀; Mar. 20,—1 ♀; Mar. 21,—1 ♂, 1 ♀; Mar. 22,—4 ♀; Mar. 24,—1 ♀; Mar. 26,—2 ♀; Mar. 30,—1 ♂; Apr. 15,—1 ♀; Oct. 4,—1 ♀. Year?: Sept. 25,—1 ♂.

ZITHA SUBCUPRALIS Zell.

1908: Aug. 24,—1 ♂. **1909:** Feb. 23,—1 ♂; Feb. 28,—1 ♂; Mar. 4,—1 ♂; Mar. 9,—1 ♂.

BOSTRA VARIANS Butl.

1908: Sept. 13,—1 ♀; Sept. 16,—3 ♀; Sept. 19,—1 ♀.
 1909: Mar. 26, 1 ♀; Apr. 8,—2 ♀; Apr. 10,—2 ♀; Apr. 14,—1 ♀; Apr. 20,—1 ♀.

BOSTRA TENEBRALIS Hmps. n.

1908: Sept. 14,—1 ♂; Sept. 15,—1 ♂; Sept. 19,—1 ♂.

BOSTRA PYROCHROALIS, sp. n. (Pl. II. fig. 43, ♀.)

♀. Head, tegulae, and abdomen whitish tinged with red-brown; thorax fiery red. Fore wing fiery red slightly irrorated with whitish, the costal edge with some dark scales towards base and alternating whitish and dark brown points on medial area; ante-medial line white, slightly excurved below costa, then inwardly oblique; postmedial line white, slightly excurved to vein 4, then slightly incurved; cilia purple-brown at base, the tips white with some red at apex. Hind wing white tinged with red-brown; the cilia purple-brown at base, white at tips.

1909: Mar. 24,—1 ♀ (type). *Ecp.* 16 millim.

DATTINIA PERSTRIGATA, sp. n. (Pl. II. fig. 40, ♂.)

Antennae of male bipectinate, with long branches to near apex.

♂. Head and thorax creamy white more or less tinged with brown; antennae with the branches brown; palpi irrorated with blackish; abdomen creamy white with dorsal fulvous-yellow bands except at base and extremity, the anal tuft with pale blood-red subdorsal streaks. Fore wing with diffused blackish streaks below end of cell, above and below submedian fold and vein 1 to beyond middle, and on each side of veins 5 to 2; a small black spot in lower angle of cell and slight point in upper angle; the streaks partly interrupted by traces of a subterminal white line with blackish points before it on veins 7, 6; the costal half of wing sometimes irrorated with blackish: a terminal series of blackish points; cilia chequered with pale blood-red. Hind wing pure white and somewhat semihyaline.

Ab. 1. Fore wing with the streaks on each side of vein 1 and veins 5 to 2 beyond the cell with pale blood-red mixed, veins 7, 6 with pale blood-red streaks except on terminal area.

♀. Thorax strongly tinged with pale blood-red, the fore and mid tibiae and tarsi suffused with blood-red, abdomen at sides and anal tuft blood-red; fore wing with the costa and cilia blood-red, diffused blood-red fasciae above and below vein 1, the streaks on veins 7, 6 and on each side of veins 5 to 2 blood-red; an indistinct obliquely curved waved subterminal blood-red line between veins 7 and 1; hind wing suffused with brown, the veins towards termen and cilia suffused with blood-red; underside suffused with brown, the costal areas, veins towards termen, and cilia of both wings blood-red.

1908: July 1,—1 ♂; July 8,—1 ♂; July 19,—1 ♂; July 24,—1 ♂; Aug. 24,—1 ♀; Aug. 27,—1 ♂ (B.M.); Aug. 28,—1 ♂;

Sept. 21,—1 ♂; Sept. 23,—1 ♂; Sept. 24,—1 ♂; Sept. 26,—1 ♂ (type); Sept. 27,—1 ♂; Sept. 29,—1 ♂. **1909**: Jan. 18,—2 ♂, 1 ♀ (type); Mar. 14,—1 ♂, 2 ♀; Apr. 1,—1 ♂; Apr. 14,—1 ♂; May 12,—1 ♂; May 21,—2 ♂; Sept. 21,—1 ♂; Oct. 22,—2 ♂; Nov. 25,—1 ♀. **1910**: Mar. 6,—1 ♂; Mar. 9,—1 ♂; Mar. 10,—1 ♂; Mar. 12,—1 ♂ (B.M.). *Exp.* ♂ 36–40, ♀ 42 millim.

DATTINIA ORNATA Druce.

1908: Feb. 24,—1 ♂; Sept. 24,—1 ♀; Sept. 29,—1 ♀; Oct. 3,—1 ♂. **1909**: Mar. 14,—1 ♀; Mar. 18,—1 ♀; Mar. 19,—1 ♀; Mar. 26,—1 ♀; Apr. 16,—1 ♀; Oct. 8,—1 ♀; Oct. 11,—1 ♀.

DATTINIA PERATALIS, sp. n. (Pl. II. fig. 41, ♂.)

Antennæ of male bipectinate, with long branches to two-thirds length.

♂. Head, thorax, and abdomen ochreous tinged with rufous, the thorax deeper rufous; antennæ with the branches brown; frons and palpi deep rufous; legs red-brown, the tibiæ and tarsi ringed with whitish. Fore wing with the basal area rufous, the rest of wing silvery white with a creamy tinge suffused in parts with rufous; antemedial line creamy white defined on outer side by rufous and with some black irroration before it, slightly waved; the medial area mostly suffused with rufous, with a creamy-white patch in and beyond the cell extending to costa; an oblique black-brown discoidal bar and slight yellowish spot below end of cell; postmedial line creamy white defined on inner side by rufous, excurved to vein 3, then incurved, a patch of blackish scales beyond it at middle; a silvery whitish apical patch defined by rather diffused black scales. Hind wing ochreous white suffused with rufous; cilia with a white line at base followed by a rufous line. Underside whitish, the fore wing and costal area of hind wing suffused and irrorated with red-brown.

1909: Mar. 14,—1 ♂ (type). *Exp.* 14 millim.

DATTINIA COSTINOTALIS, sp. n. (Pl. II. fig. 42, ♂.)

Antennæ of male ciliated.

♂. Head, thorax, and abdomen grey mixed with reddish brown and fuscous, the vertex of head whitish; pectus whitish; tarsi brown ringed with white; abdomen blackish brown ventrally except towards base. Fore wing pale brownish grey slightly irrorated with blackish; the costal edge black towards base; subbasal line black defined on outer side by whitish, angled outwards below the cell and ending at vein 1; antemedial line black, oblique to below the cell, then incurved, a quadrate patch of blackish suffusion beyond it from costa to median nervure; a slight dark mark at lower angle of cell; postmedial line blackish, indistinct except towards costa, excurved to vein 4, then oblique and sinuous, an oblique black bar

beyond it from costa; a terminal series of slight brown spots; cilia brownish white with two fine brown lines through them. Hind wing semihyaline white; a fine brown terminal line and slight line through the cilia.

1908: July 31,—1 ♂ (type). *Exp.* 18 millim.

CLEDEOBIA RADIALIS Hmps. n.

1908: July 17,—1 ♀; July 24,—1 ♂. **1909:** Mar. 26,—1 ♀; Apr. 8,—1 ♂; Dec. 10,—1 ♀.

Subfam. PYRAUSTINÆ.

ZINCKENIA FASCIALIS Cram.

1908: Sept. 30,—1 ♀. **1909:** Jan. 11,—1 ♀; Jan. 13,—1 ♀; May 5,—1 ♂.

SYLEPTA SABINUSALIS Wlk.

1908: Feb. 24,—1 ♀. **1909:** Oct. 7,—1 ♀; Oct. 14,—1 ♀.

GLYPHODES INDICA Saund.

1908: Oct. 27,—1 ♂. **1909:** May 14,—1 ♂.

AGATHODES MUSIVALIS Guen.

1909: May 10,—1 ♀.

CROCIDOLOMIA BINOTALIS Zell.

Berbera.—**1908:** Mar. 4,—1 ♂.

HELLULA UNDALIS F.

1909: Jan. 19,—1 ♀; Mar. 14,—2 ♀.

SAMEODES OCELLATA, sp. n. (Pl. II. fig. 44, ♀.)

Fore wing with scale-tooth on inner margin before middle.

♀. Head white, the frons with rufous spot, the antennæ and palpi fulvous red; thorax fulvous red; pectus and legs white, the latter tinged with red-brown; abdomen white dorsally suffused with rufous. Fore wing fulvous red; a large rounded white patch with pale red centre from upper angle of cell to inner margin, its edges slightly waved and a similar but smaller patch beyond the cell connected with the costa and extending to vein 4. Hind wing pale rufous. Underside whitish suffused with rufous.

1908: May 28,—1 ♀; Sept. 19,—1 ♀ (type); Sept. 24,—1 ♀. *Exp.* 16 millim.

LEUCINODES ORBONALIS Guen.

1908: Oct. 29,—1 ♀.

NOMOPHILA NOCTUELLA Schiff.

1908: Nov. 13,—1 ♂.

PACHYZANCLA PHÆOPTERALIS Guen.

1908: Sept. 20,—1 ♀.

PACHYZANCLA BASALIS Wlk.

1908: Feb. 24,—1 ♀. 1909: Apr. 10,—1 ♀.

PACHYZANCLA BIPUNCTALIS F.

1908: Sept. 30,—2 ♀; Nov. 24,—1 ♀.

PHLYCTENODES NUDALIS Hübn.

1908: Sept. 26,—1 ♀; Sept. 29,—1 ♀.

ANTIGASTRA CATALAUNALIS Dup.

1908: Sept. 18,—1 ♀.

NOORDA BLITEALIS Wlk.

1909: May 10,—2 ♀.

MECYNA GILVATA F.

Mandera.—1908: Sept. 3,—1 ♂; Sept. 11,—1 ♂; Nov. 13,—2 ♀; Nov. 14,—1 ♀; Nov. 18,—1 ♂. 1909: Jan. 14,—1 ♀; May 9,—1 ♀; Oct. 19,—1 ♂; Oct. 22,—2 ♂; Nov. 10,—1 ♀.
Gan Libbah.—1908: June 25,—1 ♂.

PIONEA MELANOSTICTALIS, sp. n. (Pl. II. fig. 46, ♂.)

♂ ♀. Head and thorax grey tinged with brown, the vertex of head white; palpi red-brown, white at base; pectus and legs mostly white, the fore tibiae and tarsi brown ringed with white; abdomen grey-brown with white segmental rings, the ventral surface white. Fore wing whitish tinged and irrorated with brown, the costal area browner; small antemedial black spots on subcostal and median nervures, vein 1, and above inner margin; a black point in the cell towards extremity and discoidal bar; postmedial line black, dentate to vein 4, then with oblique bar to vein 2, then retracted to below end of cell and excurved at submedian fold and slightly above inner margin; a curved series of blackish points just before termen and a terminal series. Hind wing whitish suffused with red-brown; traces of a curved brown post-medial line; a terminal series of slight brown points; cilia white with a faint brown line near base.

1908: Sept. 23,—1 ♀; Sept. 27,—1 ♀, 1 ♂ (type); Oct. 11,—1 ♀ (B.M.); Nov. 24,—1 ♀. *Exp.* 16 millim.

PIONEA RUBRITINCTALIS, sp. n. (Pl. II. fig. 45, ♀.)

♀. Head and thorax ochreous yellow tinged with rufous; frons with white lines at sides; palpi white in front at base; pectus and legs white; abdomen reddish ochreous, the ventral surface white. Fore wing ochreous yellow tinged with rufous; traces of an oblique rather diffused rufous antemedial line; a more distinct

obliquely curved diffused rufous postmedial shade; cilia white at tips. Hind wing pale reddish ochreous with traces of a rather diffused curved rufous postmedial line.

1908: Sept. 24,—1 ♀. **1909:** May 10,—1 ♀ (type). *Exp.* 18 millim.

PYRAUSTA INCOLORALIS Guen.

1909: May 3,—1 ♀.

PYRAUSTA STHENIALIS, sp. n. (Pl. II. fig. 47, ♂.)

Mid tibiae of male dilated with a fold containing a tuft of long hair, the hind tibiae with the outer medial spur minute; abdomen very long with the anal tuft long.

Head, thorax, and abdomen pure white, the shoulders with grey stripes; frons and palpi towards tips tinged with grey. Fore wing semihyaline white; the costal area suffused with grey; oblique slightly curved grey postmedial and subterminal lines. Hind wing semihyaline white with faint curved greyish postmedial and subterminal lines.

1908: May 4,—3 ♂, 6 ♀; May 6,—1 ♀; May 28,—1 ♂; Sept. 29,—2 ♀ (1 in B.M.); Oct. 15,—1 ♀; Oct. 20,—1 ♂; Nov. 13,—2 ♂ (1 in B.M.); Nov. 18,—1 ♂ (type). **1909:** Apr. 16,—1 ♀ (B.M.). *Exp.* 22–24 millim.

PYRAUSTA CONISTROTALIS, sp. n. (Pl. II. fig. 48, ♀.)

♀. Head, thorax, and abdomen pale reddish brown tinged with grey, the vertex of head whitish; palpi rufous, white at base; pectus, legs, and ventral surface of abdomen white, the fore legs brown in front. Fore wing whitish tinged with reddish brown and thickly irrorated with dark brown, the costal area rather browner; antemedial line indistinct, dark, oblique towards costa, angled outwards at median nervure and vein 1 and incurved below the cell and above inner margin; a minute dark spot in the cell towards extremity and curved discoidal striga; postmedial line dark, waved, excurved from below costa to vein 3, then retracted to lower angle of cell and erect to inner margin; a terminal series of small dark spots; cilia with a dark line near base. Hind wing whitish suffused with brown especially on terminal area; an indistinct brown postmedial line, excurved from below costa to vein 2, where it is slightly angled inwards; cilia white with a dark line near base.

♂. Browner; fore wing with a faint purplish gloss.

1908: Oct. 23,—1 ♀ (type).

Also in B.M. from Br. E. Africa, N. Kavirondo, Maramas Distr., Ilala (*Neave*), 1 ♂. *Exp.* 22 millim.

SCELIODES LAISALIS Wlk.

1908: Sept. 26,—1 ♀; Nov. 13,—1 ♀. **1909:** Jan. 17,—1 ♀; Feb. 25,—1 ♀; Oct. 17,—1 ♀.

CORNIFRONS ALBIDISCALIS, sp. n. (Pl. II. fig. 49, ♂.)

Antennæ of male bipectinate with moderate branches to near apex; frontal prominence pointed at extremity, its lower edge produced to a point before extremity.

Head and thorax red-brown mixed with some white; antennæ ringed brown and white, the branches blackish in male; abdomen pale red-brown. Fore wing pale red-brown irrorated with darker brown especially on the veins; an oblique whitish shade from base of costa; a narrow white antemedial band defined by dark scales and with irregularly waved edges; a small rather elongate white spot defined by dark scales in middle of cell and a white discoidal bar also defined by dark scales, its lower extremity somewhat curved inwards; a narrow white postmedial band defined by dark scales and with minutely waved edges, angled inwards at veins 6, 3, 2 and outwards at submedian fold, excurved at middle and incurved to inner margin; a slight dark terminal line; cilia white at base followed by a dark line. Hind wing whitish suffused with brown especially in female; a slight brown spot at lower angle of cell and indistinct rather diffused curved subterminal line; cilia white with a brown line near base.

1908: May 4,—1 ♀; Sept. 28,—1 ♂ (type); Oct. 18,—1 ♂; Nov. 13,—1 ♀; Nov. 14,—1 ♂. 1909: Apr. 5,—1 ♂; Apr. 7,—1 ♂, 2 ♀ (1 in B.M.); Apr. 10,—1 ♂. *Exp.* 20 millim.

TEGOSTOMA COMPARALIS Hübn.

1908: June 1,—1 ♀; Sept. 25,—1 ♀; Oct. 31,—1 ♀. 1909: May 9,—1 ♂; May 10,—4 ♀.

TEGOSTOMA SUBDITALIS Zell.

1909: May 8,—1 ♂.

TEGOSTOMA BIPARTALIS Hmps.

1908: Aug. 15,—1 ♀.

NOCTUELIA GLOBULIFERALIS, sp. n. (Pl. II. fig. 50, ♂.)

♂. Head and thorax white mixed with rufous; palpi red-brown; fore tibiæ with brown bands near extremities; abdomen white with slight rufous dorsal bands and streaks on anal tuft. Fore wing white suffused with rufous; an indistinct rufous sub-basal line; antemedial line red-brown, excurved above inner margin, a round white spot defined by red-brown on its outer side in and below the cell; rounded white spots defined by red-brown in and below end of cell; a postmedial white patch defined by red-brown except above below the costa, intersected by a red-brown streak on vein 7 and its outer edge indented by a wedge-shaped red-brown mark on vein 6, a white patch beyond it at apex and oblique elliptical white spot defined by red-brown below it; a dark brown terminal line; cilia white at base with a brown line near base and brownish tips. Hind wing white; an elliptical

yellowish discoidal spot defined by brown and with brown line from it to above inner margin; a brown postmedial line from costa to vein 5 and elliptical white spot defined by brown between vein 5 and submedian fold; a dark brown terminal line; cilia with series of brown striæ near base and brownish tips.

1908: Oct. 29,—1 ♂ (type). *Exp.* 18 millim.

TINEINA.

By JNO. HARTLEY DURRANT, F.E.S.

OLETHREUTIDÆ.

EUCOSMA Hb.

EUCOSMA SOMALICA, sp. n.

Antennæ fuscous. *Palpi* whitish ochreous, more or less mixed with fuscous on the outer side of the median joint. *Head* and *thorax* whitish ochreous, slightly tinged with pink; tegulæ brownish fuscous, mixed with reddish. *Fore wings* elongate, slightly dilated posteriorly, male without costal fold, apex obtuse, termen nearly straight, slightly oblique; whitish ochreous, striate with fuscous and pinkish, with fuscous markings outlined by shining pearly scales; the markings, which appear more or less irrorate with whitish owing to some of the scales being tipped with white, consist of a basal patch, obtusely angled on the cell, and an irregular central fascia becoming attenuate, or even obsolete, toward the tornus, this fascia is outwardly connected with a subapical quadrate spot; the costa is strigulate with fuscous, there is also a fuscous apical spot and an interrupted terminal line; cilia whitish ochreous, with a pinkish gloss, traversed by two pale fuscous shade-lines. *Exp. al.* ♂ 18–27 ♀ mm. *Hind wings* with 3–4 stalked; fuscous; cilia whitish ochreous, traversed by two greyish fuscous shade-lines. *Abdomen* fuscous with paler transverse lines. *Legs* whitish ochreous; tarsi spotted with blackish.

Type ♂ (7248); ♀ (7249), Drnt. Det.

1908: Sept. 19,—1 ♂; Sept. 20,—1 ♀ (type); Oct. 24,—1 ♂ (type). 1909: Jan. 20,—1 ♀. 1910: Mar. 6,—1 ♀.

The female is a little darker than the male, the pearly scaling tending to become leaden, especially toward the tornus.

TINEIDÆ.

NOMIMA, gen. n.

(νόμιμος, η, ον = conventional.)

Type: Nomima prophanes Drnt.

Antennæ $\frac{5}{6}$, with projecting scales on each joint, giving a serrate appearance, and bipectinate 3, each pectination ciliate; basal joint without pecten. *Labial palpi* porrect, clothed beneath

and at end; terminal joint short, concealed. *Maxillary palpi* and *haustellum* obsolete. *Head* rough-haired. *Thorax* smooth—perhaps slightly tufted posteriorly. *Fore wings* elongate, rather narrow, apex round-pointed, termen rounded, surface with tufts of raised scales: *neuration* 12 veins, all separate; 7 to apex, 3–4 basally approximate; 1 furcate at base. *Hind wings* 1, elongate-ovate, with small transparent space below cubitus near base; cilia $\frac{1}{3}$: *neuration* 8 veins, all separate; 4–7 nearly parallel. *Abdomen* rather slender. *Legs*: posterior tibiae long-haired above.

NOMIMA PROPHANES, sp. n.

Antennae fuscous. *Palpi* yellowish ochreous. *Head* and *thorax* dark brownish fuscous; face yellowish ochreous. *Fore wings* cream-ochreous, with a dark brownish fuscous basal patch, and with a rather broad patch of the same colour commencing before the tornus and extending around the termen to the apex; the whole wing is ornamented with glistening spots of raised scales arranged in transverse lines—these raised spots have some admixture of bluish leaden-metallic, especially on the dark patches, and on the ochreous part of the wing transverse lines of pale greyish scaling occur between them; cilia shining, dark brownish fuscous with a purplish gloss, cream-ochreous along their base and above the apex; underside suffused with fuscous, except on a yellowish ochreous apical patch. *Exp. al.* 21–25 mm. *Hind wings* shining, pale grey with brassy sheen, more or less suffused with dark fuscous above and beneath in some specimens; cilia pale yellowish ochreous. *Abdomen* yellowish ochreous, dusted with fuscous. *Legs* yellowish ochreous, tarsi tinged with fuscous.

Type ♂ (7253), Drnt. Det.

1908: Sept. 30,—1 ♂. 1909: Apr. 10,—1 ♂ (type); Apr. 15,—1 ♂.

ACHTHINA, gen. n.

(ἀχθεινός, ἡ, ὅν = irksome.)

Type: *Achthina ctenodes* Drnt.

Antennae ♀ bipectinate 2; basal joint without pecten. *Labial palpi* rather short, upcurved; terminal joint very short. *Maxillary palpi* and *haustellum* obsolete. *Head* rough. *Thorax* smooth. *Fore wings* with costa straight, apex round-pointed, termen and tornus evenly rounded: *neuration* 12 veins; 7–8 stalked, 8–9 stalked enclosing apex, 10 out of stalk of 7–9; 4–5 closely approximate, connate or short-stalked; 3 from angle, 2 at least twice as far from 3 as 3 is from 4; 1 basally furcate. *Hind wings* 1, rather short and broad, apex and tornus bluntly rounded: *neuration* 8 veins; 3–5 approximate, 2 remote from 3, 5 bent over and closely approximate to 4, or 4–5 stalked; 6–7 stalked or separate; media to below 6. *Abdomen*: female moderate, ovipositor exerted. *Legs*: hind tibiae long-haired above.

The male is at present unknown, and there is some variation in

the neururation, but the pectinate antennæ and exserted ovipositor of the female distinguish this genus from its allies.

ACHTHINA CTENODES, sp. n.

Antennæ and palpi cinereous. *Head* and *thorax* cinereous, with some admixture of fuscous. *Fore wings* cinereous, with some admixture of whitish, clearly and distinctly, but irregularly strigulate with blackish, to the number of about 12 or 13 complete lines, some reduplicate in part and with paler intermediate lines; cilia cinereous with a fuscous line near their base, and another toward their tips. *Exp. al.* 20 mm. *Hind wings* fuscous; cilia with a pale line near their base. *Abdomen* fuscous. *Legs* cinereous.

Type ♀ (7256), Drnt. Det.

1908: Sept. 18,—1 ♀; Sept. 27,—1 ♀ (type).

MELASINA Bdv.

MELASINA PSEPHOTA, sp. n.

Antennæ whitish ochreous, spotted with fuscous; male pectinate 5. *Palpi* moderate, densely scaled; whitish ochreous mixed with dark fuscous. *Head* whitish ochreous. *Thorax* whitish mixed with dark fuscous; with a dark fuscous tuft posteriorly. *Fore wings* elongate, costa somewhat arched, apex obtuse, termen obliquely rounded, with 12 veins, all separate; chalky white, strigulate and shaded with fuscous, and with the transverse markings more or less continuously edged with blackish; a fuscous basal patch, slightly angulate outward on the fold, is edged with dark fuscous except on the costa and dorsum, there is however a dark costal spot before the end of the patch with some trace of dark spots crossing the wing; at one-third from the base a more or less irregular, outwardly oblique, fuscous fascia crosses the wing, generally widening out from the costa and narrowing below the fold, with outward extension above the fold in the direction of a dark fuscous spot at the end of the cell, occurring on an oblique fuscous fascia extending, more or less conspicuously, from costa to tornus—in some specimens this fascia is connected with a fuscous costal patch preceding the apex; cilia chalky white, with two fuscous parting lines more or less interrupted by four or five whitish bars. *Exp. al.* ♂ 21–24 mm., ♀ 34 mm. *Hind wings* pale fuscous; cilia whitish, with a fuscous line near their base. *Abdomen* fuscous; female with long exserted ovipositor. *Legs* pale fuscous; anterior and median tarsi barred with dark fuscous.

Type ♂ (7260); ♀ (7261), Drnt. Det.

1909: Jan. 19,—1 ♂; Feb. 16,—1 ♂; Feb. 17,—1 ♂; Feb. 19,—1 ♂; Feb. 20,—1 ♂; Feb. 21,—1 ♂; Feb. 22,—1 ♂; Feb. 27,—1 ♂; Mar. 9,—1 ♂; Mar. 10,—1 ♂; Mar. 13,—2 ♂; Mar. 14,—1 ♀ (type); Mar. 20,—1 ♂; Mar. 26,—1 ♂ (type).

Closely allied to *recondita* Drnt., but the hind wings are distinctly broader and the termen is more erect above vein 3, where there is a slight angle, not noticeable in *recondita* which has the wings narrower and more pointed.

MELASINA RECONDITA, sp. n.

Antennæ pale fuscous; male pectinate 5. *Palpi* moderate, densely scaled; pale fuscous. *Head* pale fuscous. *Thorax* whitish cinereous mixed with dark fuscous; with a dark fuscous tuft posteriorly. *Fore wings* elongate, rather narrow, termen oblique; whitish cinereous, strigulate with blackish, and with pale fuscous markings more or less continuously edged with blackish; a basal patch is indicated by fuscous suffusion; on the costa at one-third commences an irregular pale fuscous fascia, contracted (sometimes interrupted) on the cell, thence widening, but becoming narrow from the fold to the dorsum; this fascia is connected to a pyriform costal patch of the same colour by a larger pyriform patch on the disc with some extension toward the tornus—these markings usually reach to the costa before the apex, but are sometimes disconnected; a rather conspicuous discal spot, irregular in outline, occurs at the end of the cell on the fuscous patch, below a small, oblong, dark-margined fuscous patch; cilia whitish cinereous, with seven or eight broad fuscous bars beyond a narrow fuscous dividing line. *Exp. al.* ♂ 22–27 mm.; ♀ 33–39 mm. *Hind wings* fuscous; cilia whitish, with a fuscous line along their base. *Abdomen* fuscous; female with long exerted ovipositor. *Legs* cinereous; tarsi barred with fuscous.

Type ♂ (7275); ♀ (7276), Drnt. Det.

1909: Mar. 9,—1 ♂; Mar. 10,—2 ♂ (including type); Mar. 11,—1 ♂; Mar. 12,—2 ♂; Mar. 13,—5 ♂; Mar. 15,—1 ♂; Mar. 17,—1 ♂; Mar. 18,—1 ♂; Mar. 19,—1 ♂, 1 ♀ (type); Mar. 21,—1 ♂; Mar. 26,—2 ♀. **1910:** Mar. 16,—1 ♂.

EXPLANATION OF THE PLATES.

PLATE I.

Fig.		Fig.	
1. <i>Estigmene griseata</i>	♂	26. <i>Ozarba semitorrida</i>	♂
2. <i>Secusio somaliensis</i>	♂	27. " <i>endoscota</i>	♂
3. <i>Chloridea albivenata</i>	♂	28. " <i>hemipyra</i>	♂
4. <i>Thalatha melanostrota</i>	♂	29. " <i>hemisarca</i>	♂
5. <i>Matopo heterochroa</i>	♂	30. " <i>exolvacea</i>	♂
6. <i>Aeroriesis ignifusa</i>	♂	31. " <i>mesozonata</i>	♂
7. <i>Odontoretha featheri</i>	♂	32. " <i>endoplaga</i>	♂
8. <i>Athetis discopuncta</i>	♂	33. <i>Eulocastra argyrostrata</i>	♂
9. " <i>ectomelana</i>	♂	34. <i>Aulotarache plumbeogrisea</i>	♂
10. <i>Ethiopica ignecolora</i>	♂	35. <i>Constantiodes pyralina</i>	♂
11. " <i>phœocausta</i>	♂	36. <i>Hoplotarache ectorrida</i>	♂
12. <i>Pachycoa olivacea</i>	♂	37. " <i>ceruleopicta</i>	♂
13. <i>Rabida albiviridis</i>	♂	38. <i>Tarache mesolenca</i>	♂
14. <i>Acrapex albicostata</i>	♂	39. " <i>miogona</i>	♂
15. <i>Euterpiodes pictimargo</i>	♂	40. <i>Eutelia grisescens</i>	♂
16. " <i>erocleisticta</i>	♂	41. <i>Acanthonyx seriopuncta</i>	♂
17. <i>Paratuerta nana</i>	♂	42. <i>Cerocala albimacula</i>	♂
18. <i>Enispa flavipars</i>	♂	43. <i>Auchenisa ceruroides</i>	♂
19. <i>Eublemma eremochroa</i>	♂	44. <i>Authadistis camptogramma</i>	♂
20. " <i>ochricosta</i>	♂	45. <i>Catephia pyramidalis</i>	♂
21. " <i>arenostrota</i>	♂	46. " <i>pericyma</i>	♂
22. <i>Toana nigrilineata</i>	♂	47. " <i>poliochroa</i>	♂
23. <i>Chionoxanthia leucophæa</i>	♂	48. " <i>mesonephele</i>	♂
24. <i>Edicodia strigipennis</i>	♂	49. " <i>eurymelas</i>	♂
25. " <i>melanographa</i>	♂	50. <i>Lyncstis diascola</i>	♂

PLATE II.

Fig.		Fig.	
1.	<i>Asplenias rubrescens</i> ♂.	26.	<i>Victoria sematoperas</i> ♂.
2.	<i>Tephrias trigonosema</i> ♀.	27.	<i>Selagenia eustrigata</i> ♂.
3.	<i>Plecoptera polymorpha</i> ♂.	28.	<i>Metarbela diodonta</i> ♂.
4.	<i>Magulaba grisea</i> ♂.	29.	" <i>perstriata</i> ♀.
5.	<i>Naarda nigripalpis</i> ♂.	30.	<i>Duonitus mesosticta</i> ♂.
6.	<i>Rhynchina endoleuca</i> ♂.	31.	" <i>steniptera</i> ♂.
7.	" <i>perangulata</i> ♀.	32.	" <i>simillima</i> ♂.
8.	" <i>albiscripta</i> ♂.	33.	<i>Featheria obvia</i> ♂.
9.	<i>Aclonophlebia inconspicua</i> ♂.	34.	<i>Scotinochroa minor</i> ♂.
10.	<i>Scrancia discomma</i> ♀.	35.	<i>Cenobasis chloronoton</i> ♂.
11.	<i>Sesquialtera ridicula</i> ♀.	36.	<i>Gavara leucomera</i> ♀.
12.	<i>Cenina tergimacula</i> ♂.	37.	<i>Rhodoneura hamatipex</i> ♂.
13.	<i>Tephрина prionogyna</i> ♀.	38.	<i>Calamoschena ascriptalis</i> ♂.
14.	<i>Discalma calvifrons</i> ♂.	39.	<i>Macalla purpureopicta</i> ♀.
15.	" <i>puerilis</i> ♂.	40.	<i>Dattinia perstrigata</i> ♂.
16.	<i>Ptychopoda aperta</i> ♂.	41.	" <i>peratalis</i> ♂.
17.	" <i>subtorrida</i> ♀.	42.	" <i>costinotalis</i> ♀.
18.	<i>Acidalia pyrrhochra</i> ♀.	43.	<i>Bostra pyrochroalis</i> ♀.
19.	" <i>timia</i> ♀.	44.	<i>Sameodes ocellata</i> ♀.
20.	" <i>minoa</i> ♀.	45.	<i>Pionea rubritinctalis</i> ♀.
21.	<i>Tricentroscelis protrusifrons</i> ... ♀.	46.	" <i>melanostictalis</i> ♂.
22.	<i>Eucrostes astigmatica</i> ♀.	47.	<i>Pyrausta sthenialis</i> ♂.
23.	<i>Hierochthonia featheri</i> ♀.	48.	" <i>conistrotalis</i> ♀.
24.	<i>Neromia manderensis</i> ♀.	49.	<i>Cornifrons albidiscalis</i> ♂.
25.	<i>Prasinocyma perpulverata</i> ♂.	50.	<i>Noctuelia globuliferalis</i> ♂.

6. Further Observations on the Intestinal Tract of Mammals.

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(Text-figures 1-30.)

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In this communication I describe the gut-patterns of certain mammals that I have been able to examine since the publication of a larger memoir on the Intestinal Tract of Mammals (Mitchell, 1905), and I discuss further the significance of the facts with which I am dealing. I adhere to the purpose stated in the introduction to my memoir, to "limit my observations to a definite set of facts, hoping that the examination of a continuous series by one observer, from one point of view, would yield more information than might be derived from a wider range of work over a smaller range of animals." My object was to approach a conception of the primitive pattern of the mammalian gut, to show how the complex patterns in the different groups were related to the primitive pattern, and to discuss how far such relations throw light on the systematic affinities of the groups.

In certain cases, most common in the lower types of mammals, there is no difficulty in observing the pattern. When the gut is severed near the stomach and at the distal end of the rectum, there remains only to cut the dorsal mesentery from the rectum to the stomach and to sever the portal vein and mesenteric arteries; the whole structure of intestinal tract, mesentery, and blood-vessels may then be pinned-out on the dissecting-board and the pattern observed without further trouble. Text-fig. 27

is a reproduction of a photograph kindly taken for me by my colleague, Mr. D. Seth-Smith, and shows the intestinal tract of the Elephant-Seal prepared in this way. It will be seen at once how closely it corresponds with the simplified diagrammatic drawings of dissections which are the material of the other text-figures in my former memoir and in this communication.

In most cases, however, and especially where the alimentary canal is relatively long and thin-walled, or where different portions differ notably in calibre, regions of the tract belonging to one morphological part are held in close adherence to regions belonging to another morphological part. Some of these adhesions are individual: such are more common in old animals and in animals loaded with fat or plainly diseased. Others are permanent structures, invariably present in the members of the species in which they occur—as, for example, the connections between the colon and the duodenum which have been named the cavo-duodenal and the colico-duodenal ligaments, or the attachment of the omentum to the colon. Sometimes, moreover, blood-vessels belonging to one region of the gut may traverse the adhering folds of mesentery and supply morphologically remote regions of the gut.

In extreme cases the secondary adhesions may be stronger than the primitive mesentery, and large portions of the latter may have disappeared. Sometimes, therefore, the pattern can be displayed only after tedious dissection and the cutting of many structures not easy to distinguish from the primitive mesentery; but when the process has been accomplished, the pattern of gut and primitive mesentery is revealed.

The mode in which the intestinal tract and its mesentery are folded in the body-cavity, and the secondary adhesions, pathological or permanent, that are formed, are of great surgical importance; and many anatomists, for the most part cited in my former memoir (Mitchell, 1905), have paid attention to them. Their bias towards secondary phenomena, with consequent overlooking of the relations of the gut-patterns that I have tried to work out, has made it impossible to derive a coherent picture of the morphology of the mammalian gut from their work.

The literature of surgery gives us a clear idea as to how secondary connections may be established when living membranes are in juxtaposition, and it is a fair supposition that such "accidental" structures may have become permanent features of the anatomy where they were useful. The intestinal tract is a muscular tube, constantly undergoing strong peristaltic waves of contraction. Its contents, sometimes liquid, sometimes strongly charged with gases, sometimes with solid hard lumps, are seldom quiescent, but partly from the mere action of gravity, and partly because of peristalsis, subject the wall and the delicate suspensory apparatus of mesentery with the contained blood-vessels and nerves to sudden and varying strains. These strains are of relatively little importance when the gut

is short, thick-walled, and of even calibre, as, for instance, in the case of many carnivorous animals. When the gut is relatively long, and when the thickness of its walls and its calibre vary much in different regions, as is frequently the case in omnivorous and herbivorous creatures, the danger from mechanical strain is greater. The habit of life of the creature also must be taken into consideration. Animals of placid gait, and aquatic animals living in a medium of nearly the specific gravity of their own bodies, subject the contents of their abdominal cavity to the least possible disturbance. Animals that run and leap, and especially climbing animals—as the latter are constantly shifting from a horizontal to an erect posture,—subject the contents of their abdominal cavity to a maximum strain. As adhesions may take place between portions of the gut that, although they belong to different regions, are in close contact, it is plain that we may expect to find them varying in correlation with the nature of the food, the structure of the gut, and the habits of the animal. We see readily how they may have arisen in many groups independently, and that they thus afford no definite indication of affinity. Dr. Beddard, in a communication to this Society (Beddard, 1908, p. 561), has brought together a valuable set of observations, old and new, on such secondary features of the gut, and would appear to agree with me that they cannot, as he phrases it, “yield accurate classificatory results,” as he is able to arrange them in a series of ascending stages, and to show that these stages, or some of them, occur independently in different groups.

The Primitive Mammalian Gut.

In text-fig. 1 I have drawn the primitive type to which the varied patterns displayed by the gut of mammals (when the secondary connections have been severed) can be reduced. The left-hand diagram (A) shows the pattern as it may be seen in a very young mammalian embryo; the right-hand figure (B) shows it as it appears in some of the simpler adult animals. The whole gut from the stomach (S.) to the distal end of the rectum (R.) is suspended from the dorsal wall by a continuous mesentery (Mes.) containing the blood-vessels. It consists of three definite regions. The proximal region, from the point marked 1 to the point marked 2, is the duodenal region; in birds this is usually characterised by the outgrowth of a long, narrow, single loop, but in mammals more frequently appears as a bunch of short loops not clearly marked off from the beginning of the next region. The second region, from the point marked 2 to the cæcum (C.), I have termed Meckel's tract; it corresponds, according to the position of the cæcum, with the whole or the proximal portion of the pendant loop of human embryology, and its apex is fixed in the embryo by the umbilical cord (text-fig. 1 A, M.). As a very rare abnormality in mammals, a diverticulum, known as Meckel's diverticulum,

the equivalent of the yolk-sac diverticulum which persists throughout life in a very large number of the families of birds, is to be found at the point marked in the embryo by the attachment of the umbilical cord to the apex of Meckel's tract. Meckel's tract forms the small intestine, and however the gut may be lengthened it remains a nearly closed loop, the point (3) where the post-cæcal gut passes into the hind-gut remaining extremely close to the point (2) where the duodenal region passes into Meckel's tract. It is also of some importance to notice that the lengthening of Meckel's tract to form the coils of the small intestine takes place chiefly on the proximal limb of the primitive tract; in the vast majority of mammals, however long the small intestine may be, the distal limb of Meckel's tract remains as an almost straight tube running up until it nearly meets the distal extremity of the duodenal loop. Meckel's tract in mammals differs notably from the similar region in birds. In birds the tract tends to be drawn out into definite minor loops, the disposition of which forms characteristic patterns in different groups, and the distal region of the tract, immediately proximal to the cæca, tends to form a specialised loop, folded over, and secondarily attached to the duodenal loop. The third region of the gut is what I term the large intestine or hind-gut; it stretches from the cæcum to the anus, and occupies a greater portion of the antero-posterior axis of the body than the duodenal region and Meckel's tract together.

The cæcum of mammals occupies nearly the same morphological position as the cæca of birds. In birds like the Ostrich, and in mammals like the Kangaroo or Elephant, where the hind-gut is relatively long, but little differentiated, the cæca throughout life occupy almost exactly the position indicated in text-fig. 1 B. In birds where the rectum is very short, and especially when the distal portion of Meckel's tract is prolonged into a loop, and in mammals such as Carnivores in which the hind-gut is very short and straight, the cæca appear to lie more close to the rectum. In mammals in which the hind-gut is highly differentiated, the cæca occur on the straight portion of the recurrent limb of the pendant loop at a varying distance from the point marked 3 in text-fig. 1. Thus, when the cæcum is situated distally, the recurrent limb of the pendant loop gives rise to the distal portion of Meckel's tract. When, as is more usual in mammals, the cæcum is attached proximad of the distal end of the pendant loop, the recurrent limb of the latter gives rise partly to the distal and usually straight portion of Meckel's tract, and partly to the proximal portion of the hind-gut. In birds the cæca are almost invariably paired, but as an individual abnormality a single cæcum has been recorded in several cases (*Plotus*, *Falconiformes*, *Columbæ*), and in Herons and *Baleniceps* a single cæcum is the normal condition. In mammals a single cæcum is the normal condition; but there are many anatomical facts most easily explained as vestiges of a paired condition

(Mitchell, 1905), and the paired condition is normal in some Edentates, Hyracoidea, and *Manatus*.

The hind-gut of mammals differs notably from that of birds, inasmuch as it tends to be drawn out into specialised loops forming patterns characteristic of different groups. A rather different nomenclature has been applied to these minor loops of the hind-gut by different anatomists; I propose in this communication, following, I believe, the more exact of my predecessors, to designate these loops by their morphological position. The highest point of the recurrent limb of the pendant loop, where it bends round to pass into the primitive straight hind-gut, represents what in many mammals forms the transverse colon; a loop of

Text-figure 1.

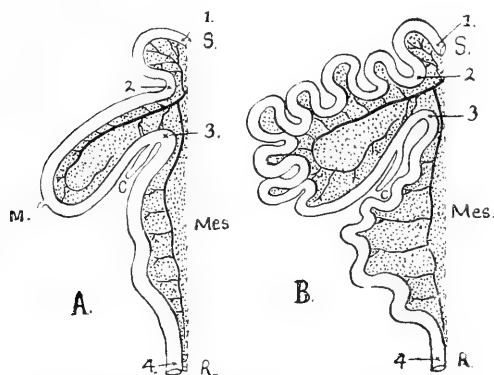


Diagram of the primitive Mammalian Gut-pattern.

A. In a young embryo. B. In a simple adult.

S. Cut junction with the stomach. R. Cut distal extremity of the rectum. Mes. Dorsal mesentery. M. Attachment of umbilical cord, position of Meckel's diverticulum. C. Cæcum. 1-2. Duodenal region. 2-3. Meckel's tract. 3-4. Hind-gut, *i. e.*, large intestine and rectum.

the hind-gut to the right, or proximad, of this is an *ansa coli dextra*; a loop to the left, or distad, of this forms an *ansa coli sinistra*. The angle between the ascending colon and transverse colon in human anatomy, on this nomenclature, might be called a vestigial *ansa coli dextra*; the corresponding angle, where the transverse colon passes into the descending colon, would be a vestigial *ansa coli sinistra*. A loop of the recurrent limb of the pendant loop, proximad of these and close to the cæcum, may be called a postcæcal loop or paracæcal loop.

It will be seen that my conception of the primitive mammalian gut differs in two respects from that presented by Dr. Beddard (Beddard, 1908, p. 591). First and most important, I regard the

primitive gut as presenting three definite morphological regions: a proximal and short duodenal region; the pendant loop, a nearly closed loop, the outgrowth of a very small part of the original straight gut, and divided by the insertion of the umbilical cord into proximal and recurrent, or distal, limbs; and third, the hind-gut, corresponding with a much longer portion of the original straight gut. Next, it possesses a cæcum, or possibly a pair of cæca, homologous with the paired cæca of birds. Unless we accept such a constitution of the primitive or ancestral mammalian gut, we are driven to the much more difficult view that these very definite subdivisions or parts have arisen independently in many different groups of mammals. I infer, therefore, that where a mammalian gut-pattern presents less specialisation than what I have described as primitive, the condition has come about by secondary reduction.

In comparing the more differentiated gut-patterns with the primitive pattern, I attach little importance to the secondary connections between proximal and distal regions; and in this Dr. Beddard appears to agree with me for the most part. The ease with which the more important of these can be established, and the apparent independent establishment of them in different groups, arise from the morphological fact that, as the pendant loop is nearly closed, the colic region and the attachment of the cæcum are brought very close to the duodenal region.

With regard to the subsidiary loops that may be formed in different portions of the gut, in mammals particularly in the hind-gut, I attach more importance to their morphological positions, and less to whether or no they form what Dr. Beddard calls "fixed" loops. Apparently that author employs two separate criteria in applying the designation. The proximal and distal limbs of his "fixed" loops are held together by a very narrow expanse of mesentery; this, however, is a question of degree, and narrow loops are linked by many gradations with what cannot be described as specialised loops at all. Next, "fixed" loops are sometimes bound down by extrinsic ligaments or secondary attachments; such are obvious adaptations, and appear to come into existence independently in different groups.

Nor do I attach much importance to the presence or absence of a spiral disposition of loops or regions of the gut. Spirals are common growth-forms, and however striking they may appear, there is little reason to suppose that the resemblances they produce are other than convergent. They are far from constant, even in individual life. The intestines of the tadpole, which are long in proportion to the size of the creature, are coiled in a tight spiral; the spiral has disappeared in the adult frog, in which the intestines are shorter in proportion to the whole length. I have found the intestines of young marsupials coiled in spirals, and comparison of my own observations with those of others leads me to believe that the chief subsidiary loop of the hind-gut in Lemurs

is disposed sometimes irregularly, sometimes in a spiral. The most conspicuous spiral arrangement in the mammalian gut, however, the colic spiral of Ruminants, appears to be constant.

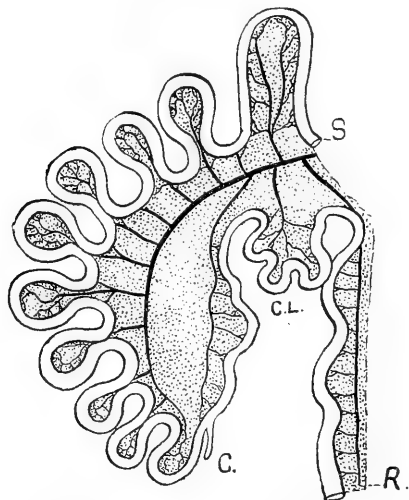
DESCRIPTIONS ARRANGED SYSTEMATICALLY.

Sub-Class MONOTREMATA.

Order MONOTREMATA.

I have already figured the gut-patterns of *Ornithorhynchus* and *Echidna* (Mitchell, 1905, figs. 1, 2), but my material was then only rather badly preserved spirit examples. By the kindness of Dr. Colin Mackenzie, who has brought from Australia a magnificent set of well-preserved examples of Monotremes and Marsupials, I have now seen several much better examples of *Ornithorhynchus* and *Echidna*. The gut-patterns of these animals are rather more alike one another and the general mammalian type than I was formerly able to make out.

Text-figure 2.



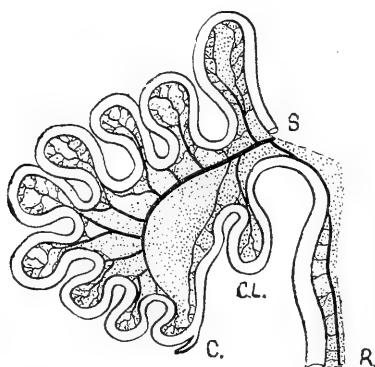
Intestinal tract of *Ornithorhynchus anatinus*.

S. Cut junction with stomach. R. Distal extremity of rectum at cloaca.
C. Cæcum. C.L. Colic loop (*ansa coli dextra*).

The duodenum in each case is a well-marked loop, and is attached by a cavo-duodenal ligament to the hind-gut at the curved portion of the hind-gut where the recurrent limb of the pendant loop bends round to join the rectal portion. Meckel's tract is suspended round the circumference of an expanse of

mesentery which is rather more elongated in *Ornithorhynchus* than in *Echidna*. The middle mesenteric vein curves through the mesentery, following Meckel's tract and giving off numerous branches to the rather regular minor loops of the tract. The cæcum, which appears to be functionless, is placed very close to the apex of the pendant loop; so that nearly the whole of the recurrent limb of the pendant loop is hind-gut. This is rather an unusual arrangement, but is present in the Sloths among Edentates and in the Mystacoceti amongst Cetaceans. Before the recurrent limb reaches the dorsal line it is thrown into a small bunch of minor loops forming an *ansi coli dextra*, less numerous, however, than I figured for *Echidna* in my earlier memoir, and placed much nearer to the dorsal middle line. Then follows a point at which the hind-gut reaches the duodenal region, to which it is attached by a secondary ligament.

Text-figure 3.

Intestinal tract of *Echidna hystrix*.

Lettering as in text-fig. 2.

The rectal portion of the hind-gut is larger in calibre and is thrown into very shallow minor loops.

Sub-Class MARSUPIALIA.

Order MARSUPIALIA.

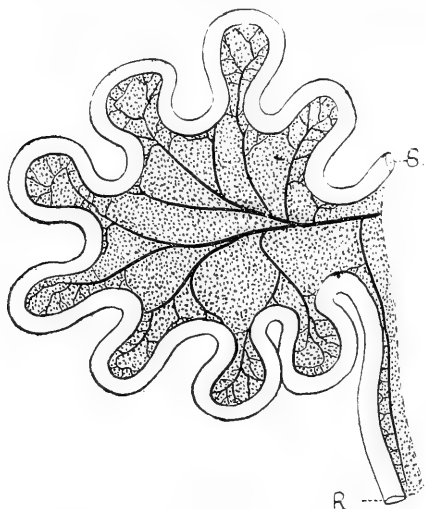
Sub-Order Polyprotodontia.

Family Notoryctidæ. *Notoryctes typhlops* (text-fig. 4).

The gut-pattern is extremely simple, showing a divergence from the primitive condition by degeneration. There is no distinction between the duodenum and Meckel's tract, the latter being thrown into irregular minor loops; there is no cæcum,

and the delimitation of Meckel's tract from the hind-gut is not marked. The mesentery is continuous, and the mesenteric veins are arranged as simple branches of the main channel.

Text-figure 4.



Intestinal tract of *Notoryctes typhlops*.

S. Cut proximal end of duodenum. R. Cut distal end of hind-gut.

The mesentery is dotted; the veins are marked in thick black lines.

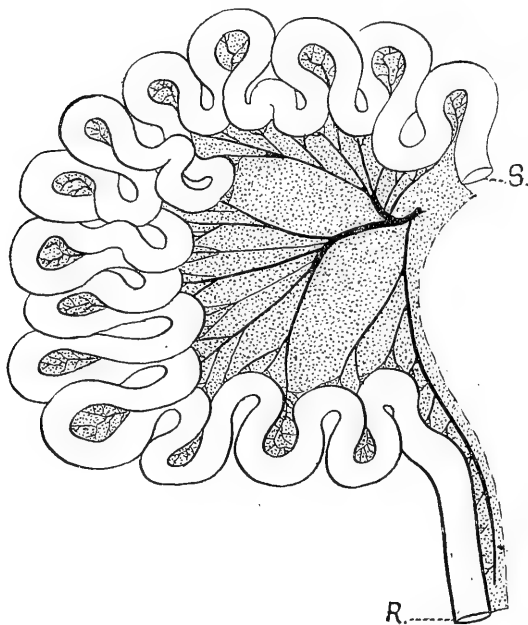
Family Dasyuridæ. *Thylacinus cynocephalus* (text-fig. 5).
Sminthopsis crassicaudata. *S. larapinta*.

In the Thylacine (text-fig. 5) the pattern does not differ in any important respect from that of *Notoryctes*, there being no cæcum and the three regions of the gut not being sharply marked off, although the grouping of the tributaries of the mesenteric vein suggests their presence. The calibre of the whole gut is rather large and approximately the same throughout. The subsidiary coils of the proximal portion of Meckel's tract are rather more numerous than is represented in the figure.

The two species of *Sminthopsis* showed a pattern almost identical with that of *Notoryctes*. Dr. Beddard (P. Z. S. 1908, p. 561, text-figs. 111 & 113) has described and figured the intestinal tracts of *Antechinomys laniger* and *Phascogale macdonnellensis*. It is clear that these small Dasyurids display a gut-pattern in all essential respects identical with that of *Notoryctes*. In the example of *Phascogale*, however, although apparently full-grown, Meckel's tract was so simple a loop that

Dr. Beddard compared it with the pendant loop of mammalian embryology, and was so fortunate as to find a remnant of the umbilical cord passing to the apex of this loop. I have never found this structure in any full-grown marsupial, and think that Dr. Beddard's example was an individual peculiarity; but it is interesting to note that it occurred precisely at the position in which I always look for it, and its presence confirms the validity of text-fig. 1 A as a diagram of the primitive mammalian gut-pattern.

Text-figure 5.

Intestinal tract of *Thylacinus cynocephalus*.

Description as in text-fig. 4.

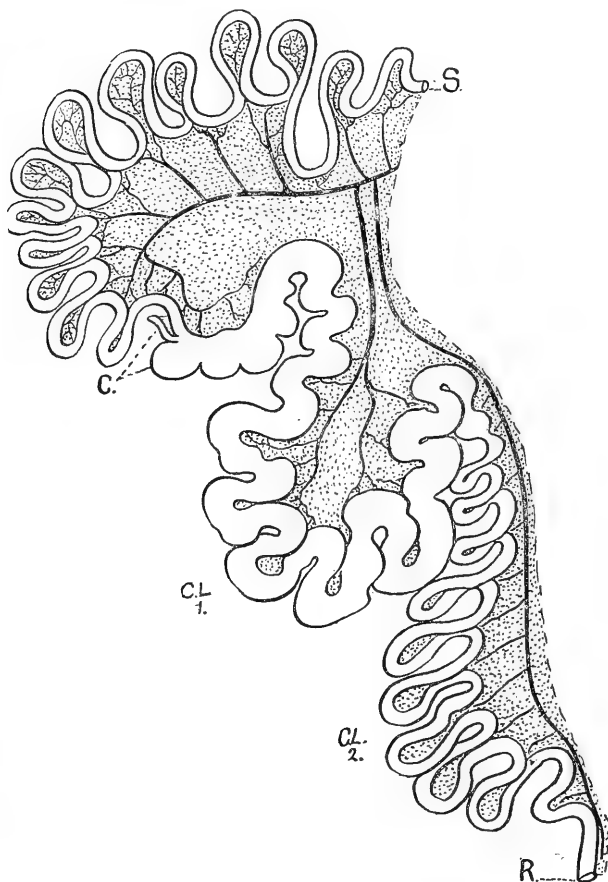
The polyprotodont marsupials display gut-patterns of great simplicity. In some (*Didelphys*, *Peragale*) the condition is practically identical with text-fig. 1 B (Mitchell, 1905). In others, such as those described above, a condition of greater simplicity has been reached, due to the obliteration of the distinction between the regions and the loss of the cæcum. This simplicity is to be regarded as secondary, as, otherwise, it would be necessary to suppose that the distinction into definite regions and the presence of a definitely placed cæcum had been acquired independently in many different groups.

Sub-Order Diprotodontia.

Family Phascolarctidæ. *Phascolomys mitchelli* (text-figs. 6, 7).
Phascolarctos cinereus (text-fig. 8).

In the Wombat the duodenal region is just distinguishable as one or two loops proximal to Meckel's tract. Meckel's tract₂ is

Text-figure 6.



Intestinal tract of *Phascolomys mitchelli*.

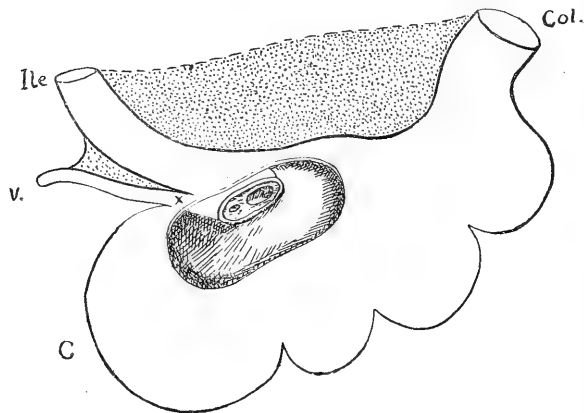
C. Cæcum. C.L. 1. Colic loop (*ansa coli dextra*). C.L. 2. Colic loop (*ansa coli sinistra*). Other references as in text-fig. 4.

very distinct, its proximal portion being broken up into a large number of regularly disposed minor loops. Distally it joins the

expanded proximal portion of the hind-gut, and the cæcum lies on the outer side of the curve at the point of junction. The first portion of the expanded colon runs up towards the dorsal line, then follows a large colic loop (C.L. 1), and finally a rectal portion of smaller calibre, thrown into rather regularly disposed minor loops (C.L. 2). A secondary connection forms a cæcal ligament attaching the cæcum to the small intestine and to the duodenal region. Another secondary connection forms a strong colio-duodenal ligament, attaching the colic loop to the duodenal region. The latter was severed to make it possible to lay out the gut so as to display its pattern.

The peculiar cæcum of the Wombat has been described and figured by Owen (Owen, 1868, p. 417, fig. 315) and by Flower

Text-figure 7.



Junction of the small intestine, cæcum, and hind-gut in *Phascolomys mitchelli*.

Ile. Cut end of ileum. Col. Cut end of colic loop. V. Vermiform appendage. C. Cæcal pouch at the proximal end of hind-gut. Part of the wall of the hind-gut has been removed to show the apertures of the ileum and of the vermiform appendage on a raised projection. X. Beginning of the solid part of the appendage.

(Flower, 1872, p. 647), and Flower's figure has been reproduced by Oppel (Oppel, 1897, p. 567). Owen's figure corresponds exactly with the portion of text-fig. 6 marked C., but it has been drawn from the other side of the gut (the right side). Flower's figure has obviously been drawn from a mounted preparation; it also shows the right side, but it has been turned upside down. It is on a larger scale, and part of the side-wall has been removed to display the mode of junction of the cæcum with the small intestine and the hind-gut. As Flower's figure is in a publication that is not now readily accessible, I reproduce as text-fig. 7 a drawing from my own dissections. It will be seen

that the cæcum consists of two portions. There is an upper elongated papilla (text-fig. 7, V.) attached to the ileum by a mesentery which is not shown in Owen's figure. This is the so-called "vermiform appendage" of the Wombat. The free portion is a solid mass of tissue closely similar to the tissue composing the human appendix; but the proximal portion, beginning just at the point (text fig. 7, X.) where the appendage blends or is embedded in the wall of the gut, is hollow. Owen regards this as the tip of the large cæcum indicated by the letter C. in text-fig. 7.

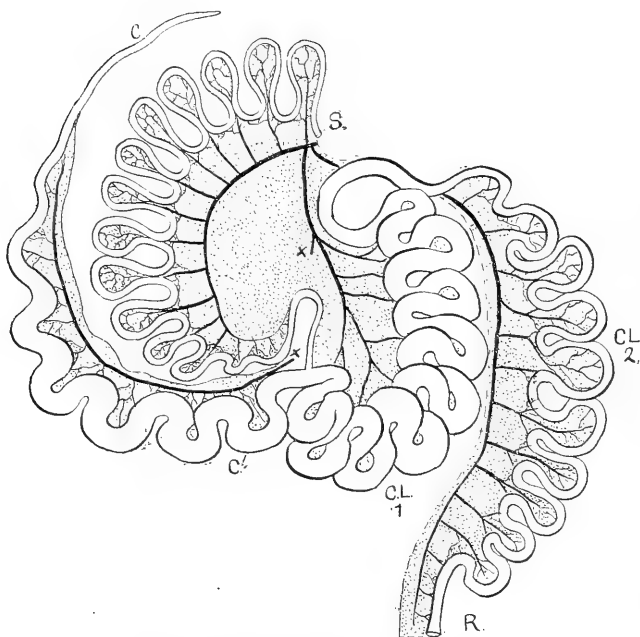
In Flower's figure the wide pouch marked C. in text-fig. 7 is lettered cæcum. The author expresses doubt as to whether or no the vermiform appendage of Owen is to be regarded as a remnant of an originally expanded cæcum, but does not refer to the fact that only the proximal portion of the vermiform appendage is hollow. He describes and figures, however, the relations of the appendage to the ileum in precisely the form in which I found them. The apertures of the ileum and of the colon into the dorsal side of the colon lie close together on a projection enclosed by a raised lip in such a fashion that it is impossible to regard the so-called vermiform appendage as a continuation of the globular proximal end of the colon. The interpretation that seems to be least doubtful is to regard the projection marked V. as the true cæcum, the greater part of which has become transformed to a solid vermiform appendage. On this view, the cæcal pouch C. is merely one of the sacculations into which the colic loop is constricted, as Owen pointed out, by two parallel bands. Owen states that he found another of these sacculations, close to the terminal one, so well marked as almost to be regarded as another cæcum. In one of the two examples of the Common Wombat that I dissected, I found another extremely well-marked sacculation forming a cæcal pouch towards the distal extremity of the colic loop. In dissecting the intestines I came upon it first, and until the whole pattern was unfolded, and the true cæcum in its proper morphological position displayed, thought that I had found a Wombat in which the cæcum had no vermiform appendage.

The length and complexity of the gut-pattern of the Wombat is in relation with the rough unnutritious diet of the animal. The pattern, however, is seen to be a simple elaboration of the primitive type. Apart from the peculiarity of the cæcum, the most interesting feature is the elaboration of the first portion of the hind-gut into a colic loop. This loop corresponds with the similar loop in *Phascolarctos* (text-fig. 8), and, like it, is an *ansa coli dextra*, and differs from the expansion on the hind-gut of other large Diprotodonts, e. g. *Dendrolagus* (text-fig. 9), which is an *ansa coli sinistra*.

By the kindness of Dr. Colin Mackenzie, I have been able to examine the intestinal tract of two well-preserved examples of the Koala (*Phascolarctos cinereus*). The duodenal region

is not sharply marked off, although in the diagram (text-fig. 8) this want of separation is exaggerated. Meckel's tract is composed of a number of very closely packed minor loops suspended at the periphery of an oval expanse of mesentery. Its distal portion bends sharply up towards the dorsal line, and then bends downwards as if it had been dragged out of place by the enormous cæcum. The cæcum is relatively, and in a full-sized Koala possibly absolutely, the longest cæcum of any mammal. At its proximal end its cavity is directly continuous

Text-figure 8.

Intestinal tract of *Phascolarctos cinereus*.

- S. Cut proximal end of duodenum. R. Cut distal end of hind-gut. C.C. Cæcum.
 C.L. 1. Colic loop (*ansa coli dextra*). C.L. 2. Colic loop (*ansa coli sinistra*).
 X.X. Cut ends of cæcal blood-vessel.

with that of the hind-gut, and is many times larger than the cavity of the ileum. It tapers gradually towards its apex. The ileum opens into the dorsal wall of the cæcum, where the latter is continuous with the hind-gut, by a small round aperture protected by a raised lip. Dr. Mackenzie called my attention to a pair of pouches placed symmetrically on the lateral walls of the gut, just where the cæcum joined the hind-gut. These could be felt before the gut was opened as a pair of thickenings which

Dr. Mackenzie had ascertained to consist of lymphoid tissue. On opening the gut, each pouch was seen to have a wide aperture towards the hind-gut, the blind apex pointing forwards towards the apex of the cæcum. These pouches suggest strongly the presence of an original pair of cæca, the apices of which have fused to form the prodigiously long cæcum. The cæcum is supported by a mesentery superficial to the primitive mesentery and suspending it to the duodenal region. It is represented as severed in text-fig. 8, and the cut ends of the cæcal vein are marked at X.X.

Immediately distad of the cæcum is an enormous colic loop, very wide in calibre and suspended at the periphery of an oval expanse of the primitive mesentery, continuous with the mesentery suspending Meckel's tract. This portion of the hind-gut must be taken as an outgrowth of the recurrent limb of the pendant loop, and is therefore an *ansa coli dextra*. It is followed by a stout-walled portion of the gut, rather smaller in calibre, and curving round from the colic loop to the rectal portion. It is at this point that the intestinal tract returns to the dorsal middle line, and a very strong secondary "ligament" attaches it to the omentum and to the duodenal region. Distad of this the calibre of the gut is again reduced, and the rectal portion is enormously expanded and thrown into a regularly placed set of minor loops attached to a meso-rectum which is more semicircular in shape than in the diagram. This expanded portion of the rectum must be regarded as an *ansa coli sinistra*.

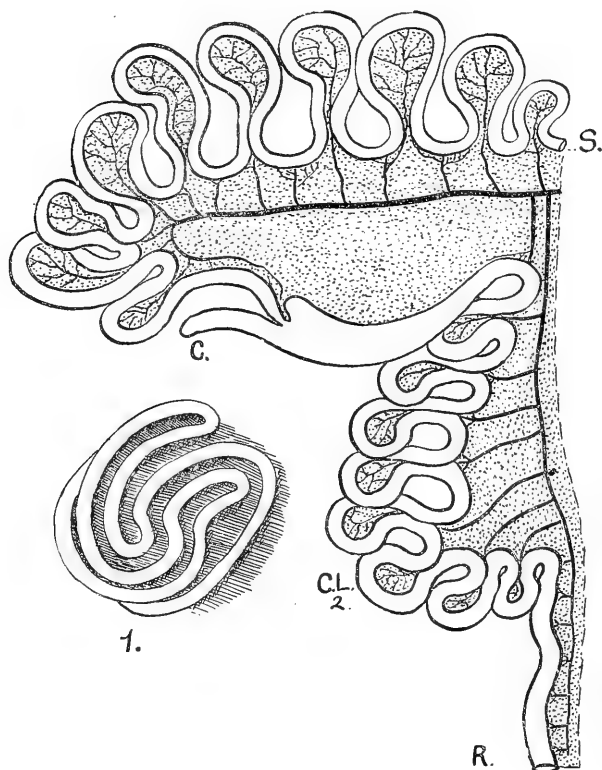
The gut of the Koala, in relation with the diet of leaves, is very long and very capacious. It is divided into four regions, nearly equal in capacity, and each "bunched up" on an expanse of mesentery. To display them on a flat diagram they had to be slightly distorted, as well as unfolded. Comparison of the figures of the gut-patterns of other marsupials, however, shows that in the Koala there is only an exaggeration of familiar features, and the pattern resembles that of the Wombat very closely. It is interesting to notice that the gut-patterns of the ruminants, in which also the whole gut has become much enlarged in correlation with the diet, are strikingly different.

Family Macropodidæ. *Dendrolagus ursinus* (text-fig. 9).

The duodenal region passes insensibly into Meckel's tract, the latter being thrown into minor folds, which are more closely set than in the figure. The example that I dissected was very young; it was born in the Society's Gardens, but died before it had left the marsupial pouch of the mother. The coils of Meckel's tract were closely packed, and in the undisturbed condition displayed the double spiral represented in the drawing (text-fig. 9, 1). The unconvoluted distal end of Meckel's tract was constricted as it entered the dilated hind-gut between a normal but rather small cæcum (text-fig. 9, C.) and a smaller

cæcal pouch of the kind frequent in *Macropodidæ*, and probably the remnant of the other member of an original pair. The distal portion of the pendant loop then passed up towards the dorsal middle line without trace of the *ansa coli dextra* marked C.L. 1 in text-figs. 6 & 8, but the proximal portion of the hind-gut immediately distad of the pendant loop was thrown into a set of

Text-figure 9.

Intestinal tract of *Dendrolagus ursinus*.

1. Spiral arrangement of part of the small intestines.

Other lettering as in text-fig. 6.

minor folds, forming together an *ansa coli sinistra*. This was supported by the mesorectum and supplied by vessels from the rectal vein and artery. I found a strong cæcal ligament, passing from the cæcum to the proximal portion of Meckel's tract, and a short colico-duodenal ligament from the proximal part of the colic loop to the duodenal region. These contained no blood-

vessels, and were severed before the drawing was made from the dissection.

In the Diprotodont marsupials the gut-pattern remains in a very simple condition, but the hind-gut is specially elongated. In all the examples that I have dissected this elongation affects the region immediately distad of the pendant loop, and may be in the form of a few wavy expansions or a more concentrated bunch of minor loops. These are all supported by a simple expansion of the mesorectum, and represent gradations from a merely expanded rectum to what would be regarded as a definite *ansa coli sinistra*. They are marked C.L. in the figures of Diprotodonts given in my former memoir (Mitchell, 1905, figs. 6, 7, & 8) and C.L. 2 in the figures of this communication. Examination of the Wombat and of the Koala have enabled me to ascertain that in these animals another "colic loop" is present. This is marked C.L. 1 in text-figs. 6 & 8, is developed on the distal limb of the pendant loop, and represents an *ansa coli dextra*.

Sub-Class MONODELPHIA.

(EDENTATA.)

Order TUBULIDENTATA.

Family Orycteropodidæ. *Orycteropus capensis* (text-fig. 10).

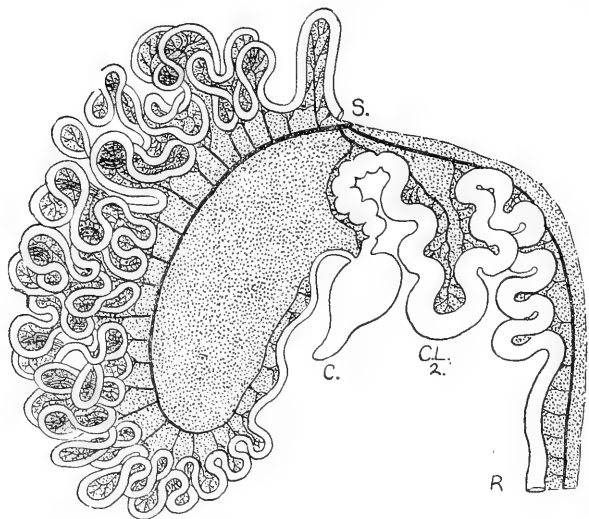
In my former communication (Mitchell, 1905) I had to depend on a description given by Flower. Since then I have had the opportunity of dissecting the intestinal tract of an Aard-vark. The proximal part of the gut is marked off as a duodenal region from Meckel's tract. The proximal part of the latter is a tube of nearly even calibre and of very great length (nearly thirty feet), thrown into minor loops arranged round an oval expanse of mesentery and corresponding with the proximal limb and apex of the pendant loop. The first portion of the recurrent limb is nearly straight. The whole tract is drained by the middle mesenteric vein, which curves round the mesentery, receiving numerous tributaries from the minor loops.

Meckel's tract opens into a relatively large cæcum, the proximal portion of which is expanded and globular. On opening the cæcum the ileo-cæcal aperture is seen to lie on the summit of a projecting process surrounded by a circular lip that may contract so as to occlude the aperture. A prominent ridge or flap in the wall of the cæcum passes from the proximal extremity of the hind-gut in the direction of the ileo-cæcal aperture, and suggests a former division of the cæcum into two cæcal pouches.

The first portion of the hind-gut is much expanded and slightly sacculated. It corresponds with the distal end of the distal limb of the pendant loop. The gut, after reaching the point nearest to the duodenum, bends sharply backwards, and is then expanded to form first a definite wide loop and then a set of minor loops, finally ending in a short straight

rectum. The wide loop appears to belong to the part of the hind-gut distad of the pendant loop, and therefore represents an *ansa coli sinistra*. As Flower has pointed out (Flower, 1872), the total length of the hind-gut is only about seven feet. Cæcal and colico-duodenal ligaments are both present, but have been removed before the diagram was made.

Text-figure 10.

Intestinal tract of *Orycteropus capensis*.

Lettering as in text-fig. 6.

The gut-pattern of *Orycteropus*, except for the specialisation of the hind-gut, has not moved far from the primitive condition, the two chief changes being the lengthening of Meckel's tract and of the hind-gut.

Order PHOLIDOTA.

Family Manidæ. *Manis tricuspis*.

I have already figured the intestinal tract of the White-bellied Pangolin (Mitchell, 1905, fig. 9). I have had the opportunity of examining another example of this mammal. The pattern was in all essential respects identical with that of the former example, but the duodenal loop was not so distinctly marked off from Meckel's tract, and the subsidiary coils of the latter were relatively larger and more numerous than in my figure; the tract was very much longer than the hind-gut. A small colico-duodenal ligament was present, but when that has been removed, as in the figure, the primitive mesentery is seen to be complete.

Order XENARTHRA.

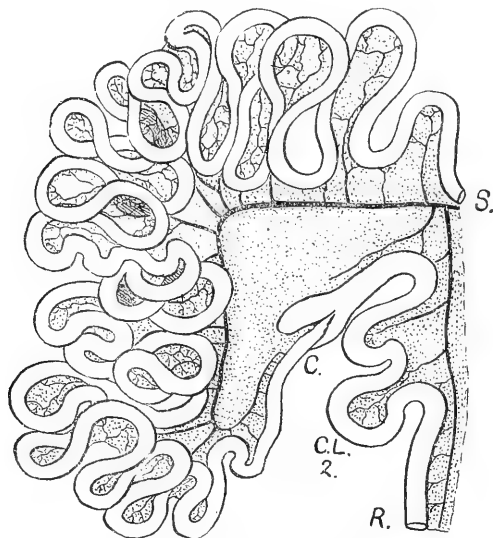
 Family Myrmecophagidæ. *Tamandua tetradactyla*.

I have been able to examine another example of the *Tamandua* Ant-eater. The duodenal region and Meckel's tract were almost exactly as represented in the figure I formerly gave (Mitchell, 1905, fig. 11), except that the minor loops of the tract were rather more numerous and more thickly set. The distal end of the tract entered the expanded proximal end of the hind-gut between a well-marked pair of shallow pouches corresponding with, but not so elongated as, the pair of cæca in the Armadillo (text-fig. 11, C.). The hind-gut was relatively rather longer, and not quite so large in calibre. It displayed a colic loop attached to the duodenal region by a colico-duodenal ligament, but distad of the pendant loop and corresponding with an *ansa coli sinistra*.

 Family Dasypodidæ. *Dasypus villosus* (text-fig. 11).

I have been able to examine the alimentary tract in a very young example, little more than a fœtus, of the Hairy Armadillo. The duodenal region was represented by two proximal loops not well separated from Meckel's tract.

Text-figure 11.


 Intestinal tract of very young *Dasypus villosus*.

S. Cut end of the gut next the stomach; R. Id., next the rectum. C. Paired cæca. C.L. 2. Colic loop (*ansa coli sinistra*).

Meckel's tract was very long, and was suspended on an elongated fold of mesentery. The proximal limb of the loop thus

formed was broken up into a numerous set of closely disposed minor loops. The distal or recurrent limb was straight for the greater part of its length, and as it approached the dorsal line, entered the expanded hind-gut between a pair of cæca relatively longer than in the adult and disposed on the right and left sides of the gut. The hind-gut distad of the pendant loop had a distinct colic loop, attached to the duodenal region by a ligament, removed before the figure was drawn.

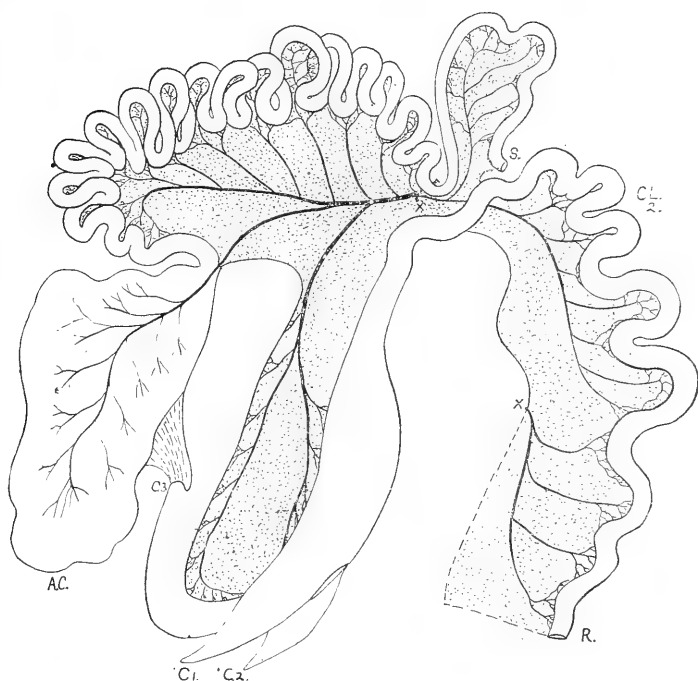
The patterns of the intestinal tracts of the Tubulidentata, Pholidota, and Xenarthra afford no evidence in favour of the existence of a super-order "Edentata." Such resemblances as they present are best explained as a common inheritance from the primitive type, and so afford no evidence of affinity. In the Xenarthra, the most characteristic features are the existence of paired cæca, which seem to be more conspicuous in the young than in the adult, and the tendency to a great elongation of the loop formed by Meckel's tract and the proximal portion of the hind-gut, a tendency which is better marked in some of the examples described in my former memoir, than in the young Armadillo figured here. The hind-gut varies considerably both in the different groups and even individually. The distal limb of the pendant loop always approaches the duodenum closely, and distad of this the hind-gut may pass nearly straight back to the rectum, may form a shallow, or a well-marked and complex loop. In both Marsupials and Edentates, the hind-gut appears to be still in a variable or almost experimental stage.

Order HYRACOIDEA. *Dendrohyrax dorsalis* (text-fig. 12).

The pattern of the intestinal tract of the Hyracoidea is the most remarkable to be found amongst mammals, and deserves special attention, because of the difficulty that has been found in assigning its due place to the Order amongst the mammalian Orders. I have already described and figured (Mitchell, 1905, p. 461) the intestinal tract of *Hyrax capensis*; since then I have been able to examine an adult example of *Dendrohyrax dorsalis* and another very young example of *H. capensis*, and to compare my own observations and interpretations with those of Dr. Beddard (Beddard, 1908 and 1909). The pattern of the tract of the Tree-hyrax (text-fig. 12), when the secondary connections have been severed and the tract laid out according to the method I pursue, corresponds in all essential respects with that of other Hyracoids. As Owen long ago (Owen, 1832) correctly stated, the whole tract, from the duodenum to the distal extremity of the rectum, is suspended by the primitive mesentery from the dorsal wall of the body-cavity. In *Dendrohyrax* I found interruption in the proximal part of the mesocolon (extending from the point marked X in the text-figure towards the recurrent limb of the pendant loop), a gap that I did not notice in *D. capensis*. The duodenal region is a distinct loop, well separated from Meckel's tract.

The proximal portion of Meckel's tract, as is usually the case in mammals, is sub-divided into a number of closely-set irregular loops. Then follows the large cæcal pouch, assumed by most authors to be the representative of the normal mammalian cæcum, but which I regard as peculiar to *Hyrax* (text-fig. 12, A.C.). The gut as it leaves this is much expanded and closely adherent to the wall of the cæcum. It then runs a nearly

Text-figure 12.



Intestinal tract of *Dendrohyrax dorsalis*.

S. Cut end nearest the stomach. R. Cut end nearest anus. A.C. Accessory or median cæcum. C. 1, C. 2. Paired cæca. C. 3. Fourth cæcum. C.L. 2. Colic loop (*ansa coli sinistra*). XX. Severed ends of rectal vein. The portion of the recto-colic mesentery edged with a broken line is where the mesentery was cut; the more proximal portion edged with an unbroken line was free from the dorsal body-wall.

straight course parallel with the long axis of the cæcum, to which it is bound by a fold of mesentery, and bearing on its morphologically ventral or larger curvature a much smaller cæcal pouch (text-fig. 12, C. 3), noted by Lonsky (Lonsky, 1903) and confirmed by Beddard, and now by myself as present in *Dendrohyrax*, absent in *H. capensis*. The tract now passes upwards towards the dorsal middle line, forming what I take to be

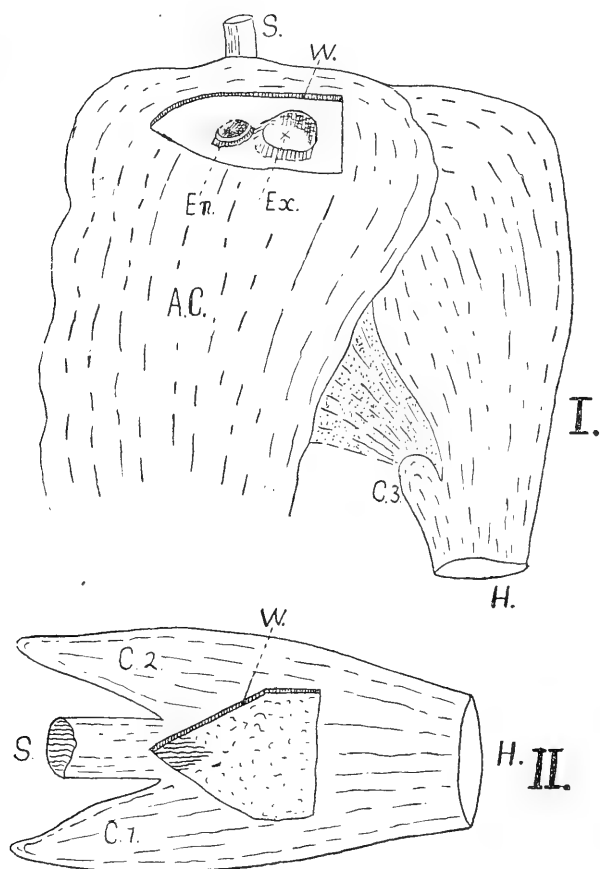
the recurrent limb of mammals generally, and bearing on this a symmetrically placed pair of conical cæca, which I take to be the representatives of the normal mammalian cæca, paired as they are in some Edentates and in the Manatee. Distally the large intestine forms first a colic loop, thrown into minor folds, from its position to be regarded as an *ansa coli sinistra*, and a rather long rectal portion. The posterior mesenteric vein, supplying the distal portion of the hind-gut, has to be severed in order to lay out the intestinal tract in the fashion of this memoir, and its cut ends are indicated at XX, in text-fig. 12.

The difficulty in interpreting the gut-pattern of *Hyrax* comes about from the presence of the cæcal pouches. The small pouch, marked C. 3 in the diagram, appears to be more due to the contraction of the gut immediately proximad of it than to any special outgrowth of the gut itself, and as it is absent in at least one species of *Hyrax*, I regard it as a character without morphological significance. The very large thin-walled pouch marked A.C. is present in all the species that have been examined. It is a large thin-walled sac somewhat puckered by two bands of muscle which, when it is fully expanded, give it an almost bi-lobed appearance, somewhat exaggerated in the figure of *Hyrax capensis* in my earlier memoir (Mitchell, 1905, p. 461). The entrance and the exit of the gut lie close together at the proximal end.

The entrance of the gut into the accessory cæcum is protected by a raised lip. George (1874, pl. 13. fig. 3), who regarded the accessory cæcum as the true cæcum, calls this entrance of the gut into it the ileo-cæcal valve, and figures it as guarded by a flap so placed as to prevent the passage of the contents of the fore-gut into the cæcum. I found no trace of such a structure, and I do not understand how, if it were present, it could act. On the other hand, the arrangement I found, by the contraction of the lip, would prevent the regurgitation of the contents of the cæcum into the proximal part of the intestinal tract. The aperture of exit leading to the distal portion of the gut is wider, and is surrounded by a shallower lip. The portion of the intestine into which it leads is closely adherent to the wall of the cæcum, and the cavity is at first slightly convoluted, forming what might be described as a separate chamber of the cæcum, but in *H. dorsalis* this is not so well marked as in the figure given by George (1874, pl. 13. fig. 4). There is a general resemblance between this cæcum and the normal cæca of those mammals in which the cæcum is capacious and relatively short. The normal cæcum of mammals, however, always appears to be a forward continuation of the hind-gut, the one cavity being directly continuous with the other in the simplest fashion, except in those cases in which it is slightly complicated by vestiges of the presence of the second cæcum of an original pair. This is unlike the complicated relation of the unpaired cæcum of *Hyrax* to the gut that leaves it. A comparison has been made between this

cæcum of *Hyrax* and the normal cæcum of the Rhinoceros. I find none but the most general and vague resemblance. The cæcum of *Hyrax* is irregular and varying in shape, supported by

Text-figure 13.



The cæca of *Hyrax dorsalis*.

- I. Anterior or accessory cæcum. II. Paired or distal cæca. S. Cut end of intestinal tract towards stomach. H. Cut end of intestinal tract towards anus.
 • W. Cut edge of gut where a portion of the wall has been removed to display the interior. A.C. Accessory or anterior cæcum. C.3. Cæcal pouch distad of A.C. C.1, C.2. Paired cæca. En. Entrance, Ex. Exit of gut.

two bands of muscle, which in certain conditions of distension give it an almost bi-lobed shape, communicates with the leaving portion of gut in a complicated fashion, and has nearly fluid

contents*. The cæcum of the Rhinoceros is a short cone tapering to a point and regularly sacculated along three bands of muscle, communicates with the hind-gut, of which it appears to be the forward continuation, by a simple wide aperture, and its normal contents are solid.

The paired cæca are conical outgrowths, placed symmetrically on the sides of the hind-gut. As shown in the figure (text-fig. 13, II.), their cavities are widely continuous with that of the hind-gut, and what I regard as the distal end of the ileum enters the hind-gut exactly in the middle line between them. In *D. dorsalis* the ileum is lined by longitudinal lappets which cease abruptly between the cæca, the lining membrane of these being smooth, and that of the hind-gut studded with filiform papillæ. The contents of the cæca consist of fæcal matter of the same consistency and appearance as that in the hind-gut. Some confusion has crept into the literature regarding the orientation of the paired cæca. As in the case of the colic cæca of birds and of mammals, whether there be a single cæcum or a pair, the cæca are the forward continuations of the hind-gut, and their apices are directed forwards, parallel with the ileum, towards the proximal extremity of the whole gut. As, however, the tract lies folded within the body-cavity, in the undisturbed condition, the portion of the gut to which the cæca are attached ascends from the distal and ventral region of the body towards the dorsal and anterior middle line, it may be said, in the phrase of Kaulla (Kaulla, 1830), that the cæca *apice pelvem spectant*. The paired cæca, in fact, lie on the recurrent limb of the pendant loop, the position in which the true cæca of all mammals lie. This morphological position, which in my opinion is sufficient to identify the paired cæca of the Hyracoidea as the homologue of the true cæca of mammals, is quite apparent if the various diagrams I have given in this memoir, and in my earlier memoir, be compared. But the homology is equally plain from another consideration. When the abdomen of any mammal is opened, the cæcum, if it exist, is found with its attachment to the gut towards the right side of the body, more anteriorly or posteriorly placed according to its place on the recurrent limb of the original pendant loop. If the cæcum be very large, and especially when it is long and coiled, it may extend towards the left side of the body, reaching well across the middle line. If it be very small, its position on the right side is obvious. As a supposed resemblance between the unpaired cæcum of *Hyrax* and the normal mammalian cæcum of the Rhinoceros has been alleged against the homology I make, I may refer to the figures of the undisturbed abdominal viscera of the Rhinoceros given by Garrod (Garrod, 1873, fig. 5) (Beddard & Treves, 1887,

* From observations on a living *Hyrax*, which was in my possession for nearly eighteen months, I infer that the contents of the intestines may pass directly from the aperture of entrance to the aperture of exit of the accessory cæcum, and that the latter gradually fills with a fluid and is discharged at infrequent intervals (usually about fortnightly), apart from the normal daily defæcation of solid fæces.

fig. 2). In these drawings the position of the cæcum on the right side is well shown. Dr. Beddard's own generalised diagrams of the mammalian gut (Beddard, 1908, text-figs. 122 & 123) show the same point. Now, if Dr. Beddard's own diagram of the alimentary tract of *H. capensis* (Beddard, 1908, text-fig. 115) be examined, it will be seen that he represents (and all my observations confirm him on this point) the paired cæca in the undisturbed condition as lying on the right side, in the true position of the normal mammalian cæcum, with which he does not homologise them, and the unpaired cæcum as attached to the gut nearly in the middle line, much to the left of the paired cæca, and therefore in a position in which the normal mammalian cæcum never lies. As a matter of fact, the accessory cæcum of the Hyracoidea, both in the young and the adult, lies in a region of the body-cavity always occupied in mammals by the coils of the small intestine.

Although Dr. Beddard (1908, p. 595) makes the general statement that the series of facts (rotation of the gut in the body-cavity, mesenterial attachments, formation of "fixed" loops) cannot yield any accurate classificatory results, he appears to rely on precisely such facts in his endeavour to show that the unpaired cæcum of *Hyrax* is homologous with the normal cæcum of mammals, and that the intestinal tract of the Hyracoidea is to be associated with that of the Perissodactyle Ungulates. As he himself has shown conclusively, rotation of the gut occurs in almost every group of mammals, and therefore its presence, or even the stage to which it has reached, does not assist us in the attempt to detect relationships. I have already (*supra*, p. 184) shown that it is necessary to distinguish carefully (a point that Dr. Beddard has overlooked) between the secondary connections and the primitive mesentery, as the former are almost certainly convergent adaptations. Even assuming, however, that the ligaments might yield evidence of affinity, those that are present in the Hyracoidea do not support Dr. Beddard's argument. A strong wide ligament attaches the unpaired cæcum to the portion of the gut which leaves the cæcum. This is more extensive in *H. capensis* (Beddard, 1908, text-fig. 115, 1) than in *D. dorsalis*, in which it extends no further than the additional small cæcal pouch (text-fig. 12, C. 3) present in that species. Dr. Beddard, in directing attention to this, points out that the single cæcum of mammals, however small, is usually, possibly invariably, attached to the adjacent wall of the gut by such a ligament. It happens, however, that the mesentery of the true cæcum in other mammals passes between the true cæcum and the ileum, that is to say, the portion of the gut entering, not leaving the cæcum. I do not know of any exception to this relationship, which is in correspondence with the appearance that the cæcum presents of being an anteriorly directed outgrowth of the hind-gut, running forwards roughly parallel with the ileum. This normal mesentery, stretching between the cæcum and the ileum, is absent in the

case of the unpaired cæcum of *Hyrax*, yet present in Perissodactyles, as in most other mammals. That there is in Perissodactyles (see *infra*, p. 222) also an adventitious set of fibres binding the true cæcum to the proximal end of the hind-gut, affords no indication of affinity. Another secondary ligament stretches from the duodenal region to the portion of the gut immediately distad of the paired cæca of *Hyrax* (Beddard, 1908, text-fig. 115, *c.d.*). The possibility of this attachment being formed depends, in my opinion, on the fact that at this point the recurrent limb of the pendant loop nearly reaches the dorsal middle line, and therefore approaches the duodenum very closely. If any importance can be attached to its presence, it clearly marks the region just distad of the paired cæca as the beginning of the hind-gut, and corroborates my orientation of the gut. A third secondary ligament well developed in the Hyracoidea is that between the omentum and the transverse colon (Beddard, 1908, text-fig. 115, O.). This also, so far as any significance can be attached to its presence, identifies this portion of the gut, distad of the paired cæca, and indicates the homology of these organs with the normal mammalian cæcum. Dr. Beddard himself sees the weight of this objection to his argument, but endeavours to get out of the difficulty by discussing the varying disposition of the corresponding attachments in different Rodents. When one is trying to prove the affinity of *Hyrax* with the Rhinoceros on the ground of the attachment of certain ligaments, the argument does not appear to be much strengthened by showing that these attachments are not the same in *Dasyprocta* as in other Rodents.

So far as I am able to follow it, Dr. Beddard's third point, relating to the presence of an *ansa paracæcalis* in *Hyrax* comparable with the *ansa paracæcalis* of Perissodactyles is unconvincing. The portion of gut (Beddard, 1908, text-fig. 113, *p.a.*) which he thus designates in *Hyrax*, just distad of the unpaired cæcum, is plainly extremely different from the huge and extremely definite colic loop, consisting of a closely applied proximal and distal limb of very wide calibre, held together by a very narrow expanse of the primitive mesentery, which forms, perhaps, the most characteristic feature of the gut-pattern of the Tapirs, Horses, and Rhinoceros (Mitchell, 1905, figs. 23-25, C.L., and text-fig. 20, *infra*). As it happened, I found no definite structure comparable with the loop figured by Beddard in *H. capensis* or in *D. dorsalis*. If any comparison with the colic loop of Perissodactyles were to be made, on the assumption that the unpaired cæcum of *Hyrax* is identical with the cæcum of Perissodactyles, the analogue would be the whole expanse of the gut from the unpaired cæcum to the point where the recurrent limb approaches the duodenum.

To sum up. If the accessory cæcum were absent, anatomists would have found no difficulty in identifying the paired cæca of Hyracoids with the normal mammalian cæcum, a structure which, although usually unpaired, frequently shows vestiges of a primitively paired condition, and less frequently is actually

paired. In their structure, morphological position on the gut, position as seen when the abdominal cavity is opened, and attachments, they correspond with the normal mammalian cæcum. The accessory cæcum of Hyracoidea differs from the normal mammalian cæcum in structure, morphological position on the gut, position in the undisturbed body-cavity, and attachments. The attempt, based on minute details of structure, to identify the unpaired cæcum of Hyracoids with the unpaired cæcum of a Perissodactyle such as the Rhinoceros, makes the presence of paired cæca still more inexplicable. I adhere, therefore, to my identification of the paired cæca of Hyracoidea with the normal mammalian cæcum. Owen (Owen, 1832) definitely compared the paired cæca of *Hyrax* with the paired cæca of Edentates and of birds, and the unpaired cæcum with the "additional single cæcum, anterior to these, found only in a few species (of Birds)." This appears to be the most reasonable interpretation of the facts. I am unaware of any reason for refusing to identify the paired cæca of Edentates (and of the Manatee) with the normal mammalian structure, and I have shown good reason for identifying the normal cæca of birds with the mammalian cæcum or cæca. I have shown (Mitchell, 1901) that what Owen calls the "anterior cæcum, found only in a few species," which, of course, is the remnant of the yolk-sac, is of frequent occurrence in adult birds, that its constant presence is a character of many groups, and that in certain cases (Mitchell, 1903) it is transformed from a vestigial structure to a well-marked glandular organ. The corresponding structure in mammals, known as Meckel's diverticulum, is a rare abnormality, but has been recorded as occurring in just over 2 per cent. of human bodies. It is a diverticulum of the small intestines lying almost exactly in the region where the unpaired cæcum of *Hyrax* is found. If this identification be correct, the unpaired cæcum, obviously functional in the adult Hyracoids, has acquired an importance that is unknown in any other group; but this is a supposition less difficult than the view that the Hyracoids display a loop of the gut identical with that of Perissodactyles generally, a cæcum corresponding in minute detail with the cæcum of the Rhinoceros and paired cæca peculiar to them and the Edentates.

Examination of the intestinal tract of *D. dorsalis*, and consideration of the points raised by Dr. Beddard, therefore, confirm the view I stated formerly (Mitchell, 1905, p. 463). The general pattern of the intestinal tract of the Hyracoids suggests no affinity with the patterns exhibited by Rodents and Ungulates. The simple duodenum, the nearly circular Meckel's tract, and the hind-gut* divided into a simple colon and rectum merely

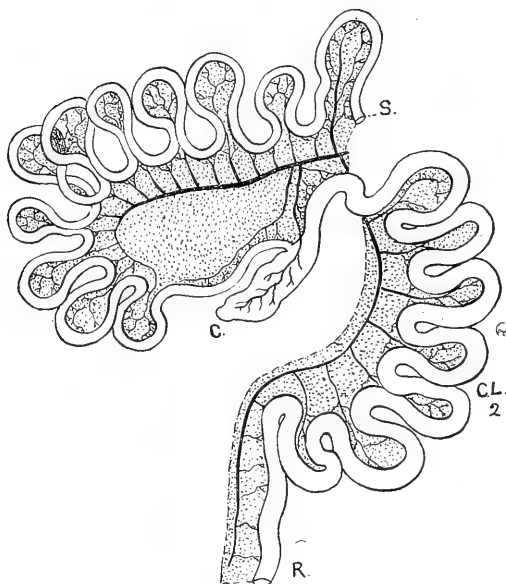
* It is, of course, plain that by "hind-gut" I imply the region distad of the paired cæca, as I reckon the part of the gut between these and the unpaired cæcum as part of the small intestine. When Beddard (1908, p. 583) stated that my description of the hind-gut was "incorrect" he was merely restating his belief that the unpaired cæcum was the true cæcum, and that all the gut distad of this, including what he took to be a paracæcal loop and the paired cæca, was hind-gut.

conform with the general mammalian plan. The presence of the paired cæca, on my view that paired cæca are a primitive mammalian feature, does not help us with the placing of the group. The most striking resemblances are with the patterns displayed by the Edentate group *Xenarthra* and the Manatee among the *Sirenia*. But it must be remembered that the common possession of a primitive simplicity is no guide to affinity.

Order PROBOSCIDEA. *Elephas maximus* (text-fig. 14).

I have been able to examine the intestines of a young Indian Elephant, and I find that the pattern, in all essential respects, is identical with what I have already figured for the African

Text-figure 14.



Intestinal tract of *Elephas maximus*.

S. Cut end of gut next stomach. R. Cut end of gut next anus. C. Cæcum.
C.L. 2. Colic loop (*ansa coli sinistra*).

Elephant (Mitchell, 1905, fig. 16). There is a separate duodenum; Meckel's tract is supported on a nearly circular expanse of mesentery, its proximal portion being thrown into numerous minor loops, and its distal portion, forming the first part of the recurrent limb, is inserted to the dorsal edge of a moderately large conical cæcum. The hind-gut is not much shorter than the fore-gut, is of larger calibre, and thrown into comparatively

large minor loops with a very short straight rectum. Although the primitive mesentery suspending the whole length of the intestinal tract is continuous, a strong secondary connection forming a cavo-duodenal ligament attaches the proximal part of the colon to the duodenal region, and has to be severed before the gut can be laid out to display its pattern. The inner dorsal wall of the cæcum displayed a median fold, running along the dorsal wall somewhat in the fashion of the typhlosole of the earthworm. It is conceivable that this may indicate an original paired condition. In the case of these very simple patterns, it is rather easy to see resemblances which may have little significance, but it is undoubtedly notable that the pattern of the Proboscidean gut in no way suggests that of the true Ungulates, and very strongly recalls that of the Sirenia (Mitchell, 1905, fig. 15).

Order CETACEA.

Sub-Order Mystacoceti. *Balenoptera physalus* (text-fig. 15).

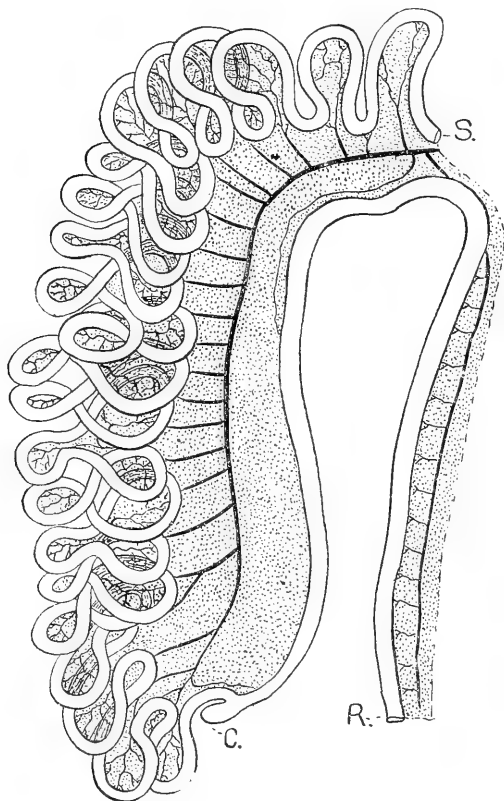
By the kindness of Mr. J. Erik Hamilton, I have had the opportunity of dissecting a young embryo of the Common Rorqual (*Balenoptera physalus*) taken from an adult captured at Belmullet, Ireland. The duodenal region (text-fig. 15) is not sharply separated from Meckel's tract. The latter is of even calibre, and is thrown into a very large number of short, regularly disposed minor loops suspended at the periphery of a much elongated oval expanse of mesentery. These loops extend to the extremity of the tract, and just where the recurrent limb of the usual pendant loop begins its straight course towards the duodenal region, there lies a single small cæcum. The hind-gut consists of the almost straight recurrent limb, a short transverse colon very close to the duodenum, but so far as I could make out, suspended at this point only by the primitive mesentery, and of a rather long nearly straight rectum.

The cæcum is short, but rather wide; its cavity is continuous with that of the hind-gut, and separated by a simple semi-lunar flap from the entrance of the ileum.

I have already described and figured the gut-pattern of one of the Odontoceti (Mitchell, 1905, fig. 17). The Toothed Whales have no cæcum, and the whole length of the gut, from the stomach to the anus, is suspended on a straight dorso-ventral mesentery, all of it, except a very short rectum, being thrown into closely-set minor loops. I ventured on the opinion, however, that this almost reptilian simplicity was not primitive, and, judging from the description given by Flower (1872, p. 428), I suggested that the gut-pattern of Whalebone Whales would approximate more closely to the common mammalian type. This is actually the case. The characteristic mammalian pattern

appears in the Rorqual; the whole proximal limb of the pendant loop is thrown into very numerous minor folds; the cæcum is placed more proximally on the loop, that is to say, nearer the tip of the loop than in most mammals; with the elongation of the mesentery suspending Meckel's tract, the recurrent limb, composed in this case almost entirely of hind-gut, is unusually

Text-figure 15.

Intestinal tract of embryonic *Balænoptera physalus*.

S. Cut end of gut nearest stomach. R. Cut end of gut nearest anus. C. Cæcum.

long, and the rectum, although straight, is also long. In the Toothed Whales, partly in relation to the diet of fish, Meckel's tract has become enormously long and its minor loops very numerous, the cæcum has disappeared, and the recurrent limb has shortened until no trace of it remains. The complexity of the stomach is so elaborate and so alike in Toothed Whales and

Whalebone Whales, that were there no other reason for associating these creatures, it would be impossible to place them far apart, and it must be inferred that, so far as the gut-patterns afford indications, the Toothed Whales are more highly modified than the Whalebone Whales. If we are to seek for indications of the affinities of the Cetacea, it must be from the Mystacoceti, and not from the Odontoceti, that we start. The difficulty is that a very simple and primitive gut-pattern affords few indications. It is plain that the Cetacean gut-pattern shows no trace of special resemblances with the patterns of the Ungulates or of the Sirenia. There is some indication of similarity with the gut-patterns of the aquatic Carnivores (see Mitchell, 1905, fig. 32, and text-figs. 26 & 27, *infra*), but the more distal position of the cæcum (*i. e.*, the greater distance from the apex of the pendant loop) and the lengthening of the hind-gut in the Carnivores present notable difference. Unfortunately, we do not know the gut-patterns of extinct mammals, but, so far as may be judged from Carnivores and Insectivores, it seems probable that the Creodonts had an alimentary tract showing a simple pattern much like those suggested in text-figs 1 A and 1 B of this memoir. The most notable peculiarity in the Cetacean pattern is the position of the cæcum towards the apex of the pendant loop, a peculiarity that occurs also in the Monotremes and some of the Edentates. The lengthening of the gut and mesentery in the longitudinal axis of the body, the great increase in the number of the minor loops on Meckel's tract, and the retention of the importance of the primitive mesentery are such adaptive characters as might be expected in animals that had taken to an aquatic life. The gut-pattern of the Cetacea, then, is compatible with the view that Cetacea represent a very primitive stock, long adapted to aquatic life.

Order ARTIODACTYLA.

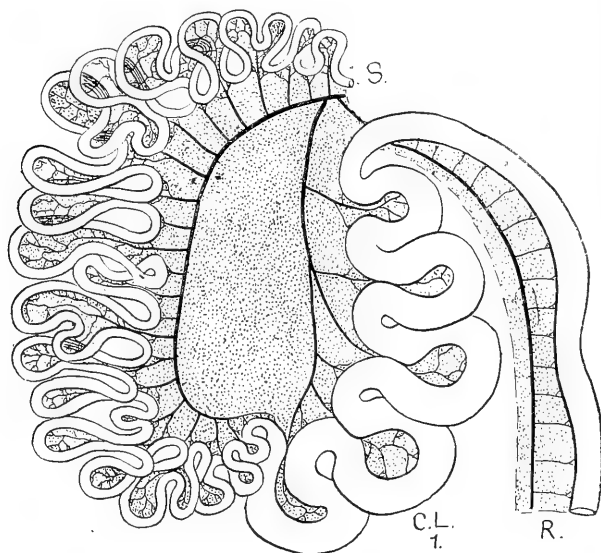
Sub-Order Non-Ruminantia.

Family Hippopotamidae. *Hippopotamus amphibius* (text-fig. 16).

The duodenum and Meckel's tract are not sharply marked off from one another. This part of the gut is extremely long (in text-fig. 16 it has been somewhat simplified), and is thrown into numerous minor folds compactly crowded on the periphery of an oval expanse of mesentery. There is no cæcum, but an increase of calibre towards the apex of the pendant loop seems to mark the point where, on the recurrent limb of that loop, the fore-gut passes into the hind-gut. The distal portion of the recurrent loop is thrown into a set of very large minor loops, attached to the edge of the mesenterial expanse opposite to that suspending Meckel's tract, and therefore representing an *ansa coli dextra*. The distal end of this colic loop, or series of minor colic loops,

approaches the duodenal region, where it is attached, by a strong rather wide ligament, partly to the duodenum and partly to the omentum. The gut then bends sharply round to form the straight rectum of moderate length.

Text-figure 16.



Intestinal tract of *Hippopotamus amphibius*.

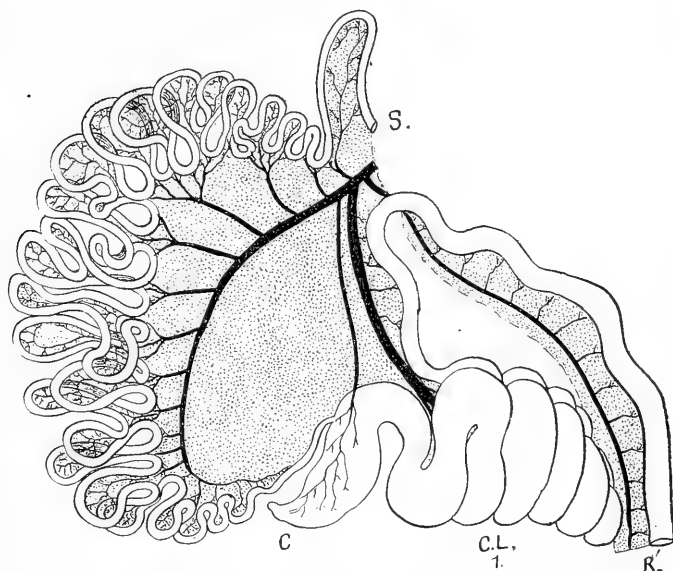
S. Cut end of gut nearest stomach. R. Cut end of gut nearest anus.
C.L. 1. Colic Loop (*ansa coli dextra*).

Family Suidæ. *Babirussa babirussa* (text-fig. 17).

In the Swine, the duodenal region is better marked off, and consists either of a single or a double loop. Meckel's tract is very like that of the Hippopotamus, being of even calibre, very long, and disposed in closely packed minor loops. From the apex the recurrent limb of the pendant loop runs dorsally a short distance and then bends to enter the large cæcum, which is a forward continuation of the cavity of the hind-gut. Distad of the cæcum, the pendant loop, in the region occupied by a set of large folds in the Hippopotamus, is developed into an enormous double spiral, really composed of a very large single loop, the proximal limb having a larger calibre than the distal limb. This spiral, in some of the Swine, *e. g.*, the common pig, and *Babirussa* is a conical mass, in shape not unlike the shell of a whelk. In *Phacochoerus* and in *Dicotyles* the colic spiral was much flatter, more like a coiled watch-spring. The hind-gut on leaving the

spiral runs up close to the duodenal region, and then bends over to form a relatively long but nearly straight rectum. The spiral loop, which from its position is an *ansa coli dextra*, is very capacious and very heavy, and the portion of primitive mesentery that supports it, and that carries the enormous blood-vessels supplying it, is reinforced by a strong band of fibres fastening it partly to the duodenal region and partly to the omentum. A similar, but much slighter secondary connection, ties the portion of the hind-gut most contiguous to the dorsal middle line (distal extremity of the pendant loop) to the duodenal mesentery.

Text-figure 17.


 Intestinal tract of *Babirusa babirusa*.

Lettering as in text-figs. 15 and 16.

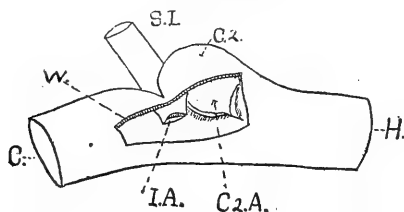
Sub-orders Traguloidea, Tylopoda, and Pecora.

I have examined the intestinal tracts of several mammals belonging to these three closely related sub-orders, since I formerly gave an account of the patterns displayed in the various families concerned (Mitchell, 1905), but as I have little of general interest to add, I shall review the group as a whole.

The duodenal region is usually well separated, forming a long distinct loop in nearly all, but rather less marked in the Traguloidea and Tylopoda. Meckel's tract is invariably enormously long, of even calibre, and thrown into a very large number of minor loops closely set round the periphery of the usual

mesenterial expanse. These minor loops cease towards the apex of the original pendant loop, the first portion of the recurrent limb being nearly straight, until it bends over to enter the cæcum. The cæcum is always present and is capacious, but not of great relative length. In *Moschus*, as an exception, it is very long and narrow. Its cavity is a forward continuation of the cavity of the hind-gut. I have already shown (Mitchell, 1905, p. 518) that the relation of the ileum to the cæcum and hind-gut often presents appearances best explained on the supposition that the normal cæcum is the surviving member of an original pair of caeca. I figured a mass of lymphoid tissue in the case of *Gazella marica*, so situated that it seemed to represent a degenerate second cæcum. In an example of *Moschus moschiferus* that I have examined since, the same portion of the gut was occupied by a distinct caecal pouch, the aperture to which was marked off by a V-shaped ridge. The iliac aperture lay on a raised lip between this and the wide aperture of the true cæcum.

Text-figure 18.

Ileo-caecal region in *Moschus moschiferus*.

- C. Cut cæcum. H. Cut hind-gut. S.I. Cut small intestine. W. "Window" cut in the wall of the ileo-caecal region. I.A. Aperture of ileum to cæcum and hind-gut. C.2. Second cæcum. C.2.A. Aperture of second cæcum to hind-gut protected by V-shaped ridge.

I can suggest no explanation of this arrangement other than that the second member of a primitive pair of caeca is less vestigial than is usual.

On leaving the cæcum the hind-gut has a much smaller calibre than is usual in mammals, being little wider than the distal end of the ileum. The length and peculiar arrangement of the hind-gut form the most characteristic feature of the intestinal pattern of this group of Artiodactyles. Immediately distad of the cæcum, there is usually a rather narrow single loop, which I called the postcæcal loop (Mitchell, 1905, fig. 22, P.C.L.). Dr. Lönnberg (Lönnberg, 1907, p. 241) objects to this name, inasmuch as he himself (Lönnberg, 1903, p. 7) had termed a similar loop in various ruminants the *ansa proximalis*. Dr. Beddard in a later paper (1909, p. 181) calls this loop the *ansa paracæcalis*. The name is of little importance, but paracæcal or postcæcal describes its position better. Its presence is variable ;

I did not find it in Traguloidea or Tylopoda, but it is present in most of the true ruminants. Dr. Beddard describes it as practically absent in *Madoqua* and as spirally twisted in *Moschus*. In a Musk-deer that I examined, it was long, but showed no trace of a spiral.

Distad of the postæcal loop, the recurrent limb of the pendant loop is disposed in a spiral coil characteristic of the true ruminants and equally well marked in the Tylopoda. It is this region of the gut that forms a set of large coils in the Hippopotamidæ, and a spiral arranged to form a solid conical mass in the Suidæ. In the Traguloidea, as has been already described by me (Mitchell, 1905) and confirmed by Beddard (Beddard, 1909), the colic spiral is very small and is not flattened. In the communication just cited, Dr. Beddard describes a somewhat similar very small spiral in the minute antelopes of the genus *Madoqua*, but in Tylopoda and all the true ruminants, except *Madoqua*, of which the alimentary canal has been described, the spiral is nearly flat and consists of a varying number of turns. This flat spiral, in the undisturbed condition, is folded against the mesentery that supports Meckel's tract in the fashion that the contiguous pages of a closed book touch one another. The spiral is much smaller than the expanse of the tract, and, in the undisturbed condition, it appears to be surrounded by the curved line formed by the minor loops of the tract. This arrangement, which is familiar to anatomists, is well represented in some of the figures given by Dr. Lönnberg and Dr. Beddard (*e. g.* Lönnberg, 1907, fig. 4; Beddard, 1909, text-fig. 14). The spiral coil is composed of a long narrow outgrowth of the hind-gut, rolled up from its apex, and the primitive mesentery belonging to the spiral has coalesced with the mesentery supporting Meckel's tract in so complete a fashion that "short-circuiting" blood-vessels appear to supply these two very different regions of the intestine indifferently. Moreover, especially where the coil is large, secondary bands of fibres unite the coil firmly with the intestinal region against which it is pressed. Unfortunately, Dr. Lönnberg does not appear to have considered these primary and secondary attachments, and Dr. Beddard's figures (*e. g.* Beddard, 1909, text-fig. 15) do not distinguish between the five different sheets of membrane to which the connections between adjacent portions of the spiral coil may be referred, that is to say, the double layer of the primitive mesentery of Meckel's tract to which the spiral coil is adherent, the double layer of the primitive mesentery of the coiled loop that forms the spiral, and the adventitious layer of connective-tissue fibres which assists in holding the coil in its place. This absence of distinction would be of no moment if the figures were, like my diagrams, intended merely to represent the general morphology of the gut-pattern, but it is another matter when the attempt is made to distinguish between species and species by the characters of the spiral coil. Dr. Lönnberg, who has made such an attempt, has devised an

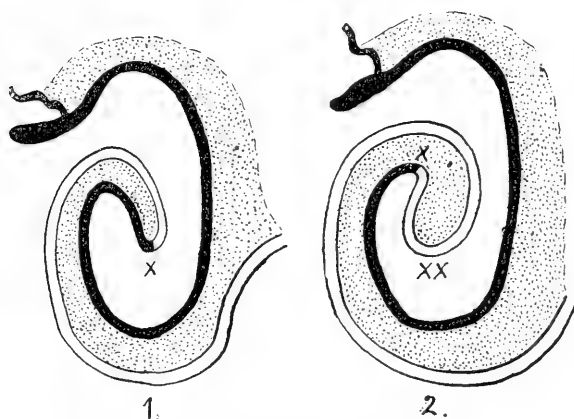
ingenious method of figuring the spiral. He selects what he takes to be the apex of the loop, and up to this point tints the entering limb of the intestine black, leaving the limb of exit from the apex outwards round the spiral in grey (Lönnerberg, 1907, fig. 4). Dr. Beddard has adopted Lönnerberg's method and has carried it further. In a set of diagrams (Beddard, 1909, text-fig. 13) he represents the colic spirals of six animals and arranges them in two series, each series indicating what he describes as a distinct type of spiral. In each case he has selected what he takes to be the apex of the loop, and, like Lönnerberg, shades the entering limb black, the limb of exit grey. In one series, containing *Madoqua phillipsi*, *Cephalophus dorsalis*, and *Moschus moschiferus*, the entering limb of the intestine is on the smaller curve of the spiral as it approaches the apex, and if the apex happens to point towards the end of the long axis of the spiral, away from the point of entrance, then the entering limb finishes on the caecal side of the apex. In the second series, containing *Tragulus stanleyanus*, *Cephalophus maxwelli*, and *Antilocapra americana*, the entering limb of the intestine lies on the larger curve of the spiral as it approaches the apex, and if the apex happens to lie towards the end of the long axis of the spiral away from the point of entrance, or be imagined to have grown round to that point, then the entering limb finishes on the opposite side of the apex from what happens in the first type. This distinction between the types of spiral is stated by Dr. Beddard to be so important that the presence of one type in one species of *Cephalophus*, and of the other in another species of that genus, is a generic distinction, confirming certain undesignated differences in external characters which "appear to him to be quite as great as those which distinguish certain other genera of Antelope."

It is plain, however, that the reality of the distinction on which Dr. Beddard relies, depends on the actual point selected as the apex of the spiral. In text-fig. 19 I have reproduced the drawings which Dr. Beddard gives as the first examples of each type (Beddard, 1909, text-fig. 13, 1, 2), with the alteration that they are reversed as in a mirror, to make easier comparison with Dr. Lönnerberg's figure (Lönnerberg, 1907, fig. 4) and my own diagrams, and with an addition to which I shall refer presently.

Obviously, if Dr. Beddard had continued the black shading representing the ingoing limb of the intestine from the point marked X, where he left it in the figure of *Tragulus*, to the point I have marked XX in the same figure, the two "types" of spiral would have been in every way identical. Anyone who has attempted to follow the closely adpressed limbs of a complicated ruminant spiral on the actual specimen, will appreciate that the fixing of the actual apex is a difficult judgment and not a substantial basis for the discrimination of types or the determination of genera. The judgment is the more difficult, because, as I have already explained, any two contiguous portions of the

spiral may be united either by their own primitive mesentery, by the primitive mesentery of Meckel's tract, against which they are fixed, or by adventitious fibres. There is, however, a definite morphological criterion. The primitive mesentery of the loop which is coiled into a spiral, whether it be retained in whole or in part, fused with or replaced by the mesentery of Meckel's loop or adventitious fibres, must have been attached along the primitive dorsal line of the gut, that is to say, the side of the hind-gut opposite to that on which the cæcum lies, the side into which the ileum opens. In text-fig. 19 I have dotted in the primitive mesentery, and it will be seen at once that in the figure of *Madoqua* Dr. Beddard has adjudged the apex correctly (X),

Text-figure 19.



Diagrams of Beddard's types of colic spirals.

1. *Madoqua phillipsi*.

2. *Tragulus stanleyanus*.

Modified from Beddard (1909, text-fig. 13, 1, 2). The distal end of the ileum, the cæcum, and the entering limb of the intestine in black; the outgoing limb is unshaded. X. Beddard's apex, the true apex in 1. XX. The true apex in 2. The dotted surface is the primitive mesentery of the loop.

but that in the figure of *Tragulus* he has adjudged it incorrectly. If in that figure the point marked X were the apex, then the mesentery would be attached to the wrong side of the gut. If, on the other hand, the mesentery be considered, the point that I have marked XX is seen to be the true apex, and the blackening of the ingoing limb should have been continued from X to XX, so abolishing the distinction between the two types. Precisely in the same way, in Dr. Beddard's figures of *Cephalophus maxwelli* and *Antilocapra americana* (Beddard, 1909, text-fig. 13, 2a, 2b) and in Dr. Lönnberg's figure of the Elk (Lönnberg, 1907, fig. 4), from which Dr. Beddard's method was taken, the point that has

been selected as the apex would place the mesentery on the wrong side of the gut. The supposed distinction in type does not exist.

I do not doubt but that an intensive study of these ruminant coils may lead to very interesting results. It is important to realize, however, that a naïve comparison and description of such complex structures may be extremely misleading.

Distad of the colic spiral the recurrent limb of the pendant loop undergoes a further complication before it reaches the dorsal middle line. The outgoing limb of the spiral, still with its mesentery adherent to the mesentery of Meckel's tract, pursues a circular course, following the line of the secondary coils of Meckel's tract and lying between this and the spiral itself until it reaches the duodenal region, where its suspension is usually reinforced by a colico-duodenal ligament, and then bends round to form the rectum, which passes backwards towards the anus suspended in the usual fashion by its own primitive mesentery. The adherence of this special coil to the mesentery of Meckel's tract is so close, that I have never been able to dissect it off with any portion of its own mesentery, and I suspect that this mesentery has disappeared. In the diagrams that I have given of Traguloidea, Tylopoda, and Pecora (Mitchell, 1905, figs. 19-22), this portion of the gut is marked S.F., supra-meckelian fold, and is displayed as dissected off and free from mesentery. This region appears to be simplest in the Traguloidea and the Tylopoda, but in an example of the White-tailed Gnu (*Connochaetes gnu*) I was surprised by finding it reduced to a single quite narrow loop. In the Giraffe it is very complicated, forming, instead of a wavy line round Meckel's tract, a set of irregular loops in the space between the tract and the spiral coil, rather like a similar series that Dr. Lönnberg has figured in the case of a fetal Elk (Lönnberg, 1907, fig. 4). In some of the deer, sheep, and goats that I have examined, the general course of this loop is a sweeping curve concentric with the curve of the minor loops of Meckel's tract, but at the distal end, just before bending over to form the rectum, it gives rise to a quite definite, straight, and rather narrow loop, stretching across towards the spiral coil and sometimes even crossing a portion of the coil.

I am reluctant to suggest homologies between the minor loops found on the very peculiar hind-gut of this group of Artiodactyles and the minor loops found in the hind-gut of other groups, as it seems to be plain that we should have first to trace such loops down to their form in the ancestral Artiodactyle, Rodent, and Primate, and so forth, before instituting any valid comparison between their appearances in the higher members of these different groups. In the very general sense, however, that the distal or dorsal extremity of the recurrent loop corresponds with the transverse colon, and a specialized outgrowth to the right of this may be named an *ansa dextra*, a specialized out-

growth to the left an *ansa sinistra*, then both the spinal loop and the supra-meckelian fold of Pecora, Tylopoda, and Traguloidea may be taken to represent *ansae dextrae*.

Further work, and the consideration of the points raised by writers who have followed me, have not given me any reason to modify the general summary I gave in 1905 (Mitchell, 1905, p. 476):—"The Ruminant Artiodactyles display a pattern peculiar to the group, and characterised by the enormous length, special modification, and arrangement of the hind-gut. In all, the hind-gut displays three well-marked regions: a spiral loop simpler in *Tragulus*, in" (most of) "the others forming a closely-coiled, flat, watch-spring like arrangement, folded over on the mesentery that supports Meckel's tract; a supra-meckelian fold which, in the characteristic and most specialised cases is stretched round Meckel's tract just at the line where the minor folds leave the mesentery, and which is drained by branches from the vessels of Meckel's tract; and a rectal portion, the degree of convolution of which varies nearly directly with the size of the animal.

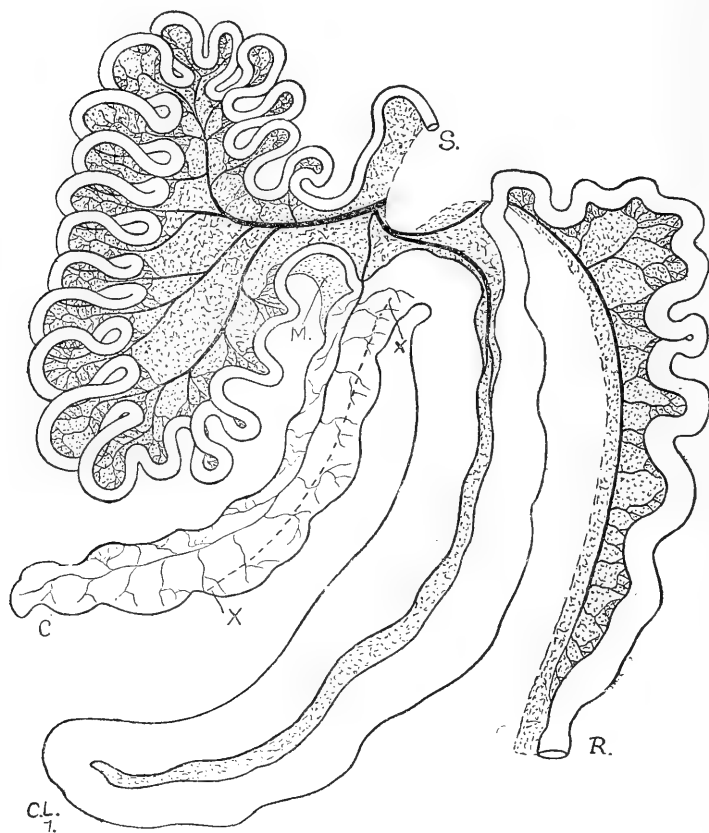
"The non-ruminant Artiodactyles display a pattern fundamentally similar to, but less complicated than, that of ruminant forms. Meckel's tract is almost identical in its disposition. The spiral coil of the hind-gut" (usually, not in the Hippopotamus) "is present and is very large, but its calibre is wider in proportion to its length, and the coiling is not so flat. There is no more than a trace of the supra-meckelian fold, so that the hind-gut, although long, is less differentiated."

Order PERISSODACTYLA. (Text-figure 20.)

I have little to add to the account I have already given (Mitchell, 1905, p. 476, figs. 23, 24, 25) of the gut-pattern of the *Rhinoceros*, Tapirs, and Equidæ. For convenience, I repeat as text-fig. 20 the figure I have already given (Mitchell, 1905, fig. 25) of the gut-pattern of *Equus granti*. I have added at M. the portion of primitive mesentery between the cæcum and the ileum, and at XX have marked the line along which the cæcum is tied by adventitious fibres to the colic loop. I have verified these points on the domestic horse, as no example of a zebra was available. In the three families the pattern is quite definite and remarkably uniform. The duodenum is a distinct loop, Meckel's tract is relatively short and compact, the cæcum is very capacious, but relatively smaller in the *Rhinoceros* than in the others, and situated rather high up on the recurrent limb of the pendant loop. It is greatly exceeded in capacity by an enormous narrow loop, each limb of which is large in calibre, formed as an outgrowth of the distal portion of the recurrent limb. The hind-gut then bends round to form the relatively simple rectum. The cæcum is connected with the distal extremity of the ileum by a short double fold of mesentery, the usual remnant of the primitive mesentery which is found in this situation in

most mammals. It extends from the base of the cæcum only along a very small proportion of the length of that organ. In addition, a layer of stout fibres, quite distinct from true mesentery in appearance and relations, binds together the two limbs of the

Text-figure 20.



Intestinal tract of Equidæ.

Slightly altered from Trans. Zool. Soc. 1905, fig. 25. S. Cut end of intestine nearest stomach. R. Cut end of intestine nearest anus. C. Cæcum. C.L. 1. Colic loop (*ansa coli dextra*). M. Remnant of primitive mesentery between ileum and base of cæcum. XX. Line of attachment of the adventitious fibres (removed in the figure) which tie the cæcum to the colic loop.

enormous colic loop, and passes over from them to the cæcum. This secondary attachment is least strong in the Rhinoceros, but in the Tapiridæ and Equidæ ties down the greater part of the

length of the cæcum to the colic loop. There are also strong cavo-duodenal and colico-duodenal ligaments.

The remarkable similarity of the gut-patterns of the three families of Perissodactyles contrasts strongly with the fact that there is no resemblance between the Perissodactyle and the non-ruminant and ruminant Artiodactyle patterns. The Swine are omnivorous with a tendency towards vegetable diet; the Hippopotamus and all other Artiodactyles are, like the Perissodactyles, vegetarian in diet. In all the hind-gut is capacious in relation to the diet, but the pattern, none the less, follows affinity rather than function.

Order RODENTIA. *Dipus ægyptius* (text-fig. 21).

I have little to add to the account I gave in 1905 (Mitchell, 1905, figs. 26-30) of the intestinal gut-patterns displayed by Rodents. The gut tends to be relatively long, no doubt in association with the chiefly vegetarian diet. The duodenal loop is usually very well marked off from Meckel's tract, the latter always being supported on an oval expanse of mesentery, and varying only to the extent to which it displays minor loops. The cæcum is usually capacious, long, and sacculated. Remnants of an originally paired condition are frequent. The cæcum, especially when long, tends to be coiled in a spiral, and this coiling may involve not only the distal portion of Meckel's tract, but the proximal portion of the hind-gut.

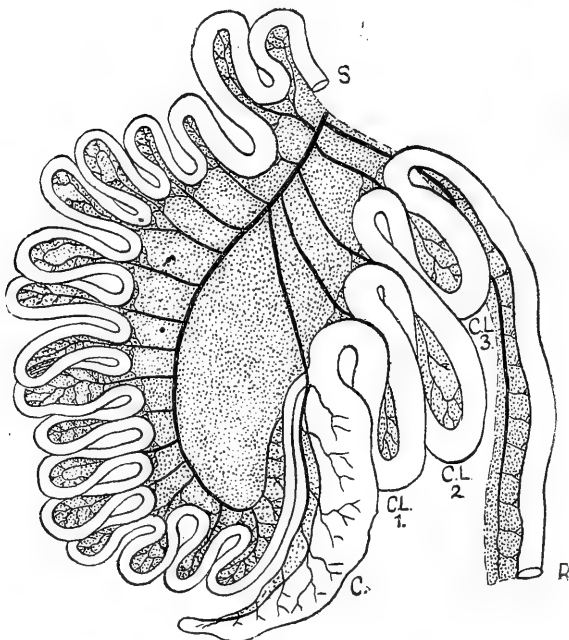
Even when the gut is relatively short, traces of the spiral condition are frequent, suggesting that in some Rodents, especially small omnivorous types, the gut has been shortened secondarily from the longer condition normal in the group.

The cæcum is placed rather high up on the recurrent limb of the pendant loop. The remaining portion of the latter varies in a remarkable degree, both in species and in individuals. The most common condition is the presence of two rather narrow colic loops, but these may be reduced to a single loop or there may be three (text-fig. 21, C.L. 1, 2, 3). The most proximal loop (C.L. 1) is the portion that tends to be involved in the spiral twisting of the cæcum, and is what has been termed a paracæcal or post-cæcal loop. The two more distal loops (C.L. 2, 3) may be spirally twisted, either separately or together, but in the more common case they are untwisted. I cannot regard this occasional spiral arrangement as indicating any homology between these loops and the spiral of Artiodactyles, or as suggesting any special affinity between Rodents and Artiodactyles. The colic spiral of the Artiodactyles, especially of the Ruminants, is an extremely definite formation, invariably present in the adult and appearing at a very early stage in embryonic life. In Rodents it varies from individual to individual, may involve one or two loops, and is often inconspicuous or absent in small or relatively young individuals. The spiral formation that

occurs frequently in Rodents and is extremely rare in other groups, so that it may be designated as a Rodent peculiarity, affects the cæcum.

The colic loops may be pressed against the mesentery of Meckel's tract in such a fashion that their own primitive mesentery may be partly obliterated and replaced, either by the mesentery of the tract, or by adventitious fibres. In *Dipus* (although in this respect text-fig. 21 is somewhat simplified and diagrammatic)

Text-figure 21.



Intestinal tract of *Dipus aegyptius*.

S. Cut end of the gut nearest to the stomach. R. Cut end of the gut nearest to the rectum. C. Cæcum. C.L. 1, 2, 3. Colic loops. C.L. 1. Paracæcal loop. C.L. 2 & 3. *Anse coli dextrae*.

and in other forms with a relatively simple gut, it is still possible to dissect away the colic loops and to unfold them to show their primitive pattern with a minimum of cutting. In other forms, especially those in which the loops are long, the adherence between them and the tract is so elaborate as to recall the condition in Artiodactyles, and the gut cannot be laid out to show its primitive pattern without extensive destruction of mesentery, blood-vessels, and secondary attachments. I am

convinced, however, that such vague resemblances between Rodents and Artiodactyles are convergent.

At its most dorsal extremity the recurrent limb of the pendant loop sweeps round to be continued backwards as the rectum. In *Dipus* and in many other Rodents the rectal portion is relatively simple. It may be much lengthened, especially in its proximal portion, and this lengthening may take the form of a single rather narrow loop, an *ansa coli sinistra*, as for instance, in *Hystrix*, or, as is more common, a much-contorted loop or number of loops, as in *Lagostomys* and *Dolichotis*. I do not attach much importance to this distinction, as I have found both forms in different examples, both apparently adult, of *Atherura*, and in very young and adult examples of some other species.

Variability appears to be a marked character of the subsidiary loops of the hind-gut in Rodents. Three writers have given a good deal of attention to the matter. Tullberg, with whose work, unfortunately, I was unacquainted when I wrote in 1905, published a most valuable monograph on the group (Tullberg 1899), in which a long section and many plates are devoted to descriptions of the gut of a very large number of Rodents. Tullberg devoted himself chiefly to the gut and its attachments as seen in the unfolded condition when the abdominal cavity is opened, but there are few features that cannot be understood from his careful figures. My work followed in 1905, and later, Dr. Beddard (Beddard, 1908), following the method of Tullberg, rather than mine, called attention to a good many differences that he had noted in examination of some of the species that Tullberg had described, and added descriptions of the conditions he found in other species not described by Tullberg. I have tabulated the results of the three writers. It would be a waste of space to give the details; it is enough to say that the colic loops of Rodents appear to differ individually and at different stages of growth, in number, attachments, degree of spiral coiling, relative length, and distinctness (*i. e.*, definite narrowness, or width and minor expansions). I hesitate, therefore, to follow Tullberg, even in his cautious use of these structures in the classification of Rodents themselves, and I think it an unwise adventure to pursue the comparison of the individual loops from Rodents to other groups. With the reservation that these colic loops are rather inconstant, it is possible to distinguish them up to a point. Immediately distad of the cæcum lies what Tullberg calls the paracæcal loop, corresponding with what I have termed the postcæcal loop. This may be absent, imperfectly formed, definite, nearly straight, twisted with the cæcum, or showing an independent spiral. Next come the two loops of the recurrent limb that are most commonly present in Rodents. These are termed by Tullberg *ansæ dextræ* 1 and 2. Frequently only one is present, especially in young examples of a few days old. Dr. Beddard, unfortunately, has confused the matter by labelling the upper or more distal of these the *ansa sinistra*

(Beddard, 1908, text-fig. 116); the term *sinistra* belongs to a more distal region of the gut, and Tullberg's definitions, descriptions, and figures make this point quite clear. These *ansæ dextræ* may be definite and narrow, spirally twisted separately or together. The three loops C.L. 1, 2, 3 in the diagram of *Dipus* (text-fig. 21) represent a paracæcal loop and two *ansæ dextræ*. Distad of the highest point of the recurrent limb, and to the left of the equivalent of the transverse colon, there may be another region of expansion. When this subsidiary loop is simple and narrow, Tullberg recognises it as distinct and calls it the *ansa sinistra*; when it is thrown into irregular minor folds, he leaves it undesignated. As I have already pointed out, I have found both conditions of this expansion in different examples of the same species, and therefore do not attach much importance to it. But, definite or irregular, if it be named at all, *ansa sinistra* is the correct name. It is absent in *Dipus*.

The gut-pattern of Rodents, then, displays usually a separate duodenum, a well-defined Meckel's tract, a cæcum frequently spirally twisted, and an elongated hind-gut, variable in the number and nature of the subsidiary loops which may be developed.

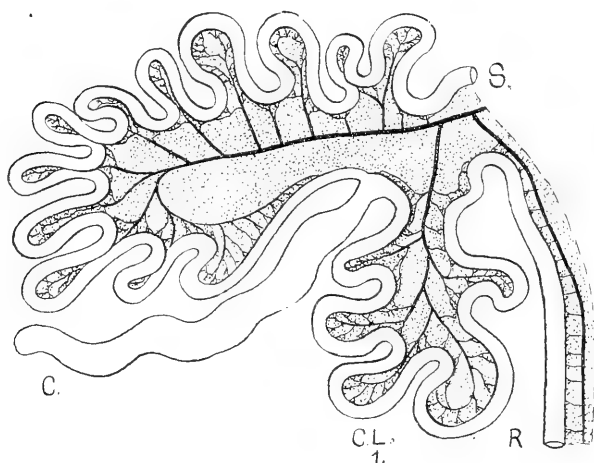
Order INSECTIVORA. *Macroscelides* species? (text-fig. 22).
Talpa europæa (text-fig. 23).

Taking the examples of animals grouped together as Insectivora that I had been able to examine when I wrote before (Mitchell, 1905) and those that I have seen since, I cannot make up a series approaching completeness. Putting together my own observations with what I am able to gather from other writers, I think that three types of different degrees of simplicity can be distinguished among the gut-patterns of Insectivora. In *Macroscelides* (text-fig. 22) the duodenal region cannot be recognised as separate from Meckel's tract. The latter is thrown into rather simple short loops round the whole of the descending limb and a small portion of the recurrent limb of the pendant loop; then follows a long, nearly straight portion running up towards the dorsal line. The cæcum is enormous, and is attached high up on the recurrent limb of the pendant loop. The distal portion of the pendant loop is expanded to form a very large nearly closed colic loop, thrown into a number of minor loops. In the undisturbed condition this lies folded against the mesentery of Meckel's tract, but I found no secondary connection. The recurrent loop then bends round to form the straight rectum. The superficial resemblance between this pattern and that presented by some of the smaller Diprotodont Marsupials, such as *Phalangista vulpina* (Mitchell, 1905, fig. 5) is extremely close. When I had finished the drawing I thought that it had a familiar look, and on hunting through my notes, I found that, from the point of view of this memoir, it would

have been almost unnecessary to draw a second figure but for the fact that the colic loop is an *ansa coli dextra* in *Macroscelides*, and probably is not so in *Phalangista*.

In *Talpa europæa* (text-fig. 23) the pattern is rather simpler. The duodenal region is rather more distinct, although in the diagram this is over-emphasised; Meckel's tract consists of a number of rather long minor loops occupying the whole of the proximal limb of the pendant loop. There is no trace of a cæcum, and nothing else to indicate where the ileum passes into the hind-gut. The recurrent loop runs straight up towards the dorsal middle line, and, just before bending round to form the straight rectum, gives rise to a single very narrow and long colic loop (an *ansa coli dextra*) which, in the unfolded condition, is bent over towards Meckel's tract and shows a trace of spiral twisting.

Text-figure 22.



Intestinal tract of *Macroscelides* species.

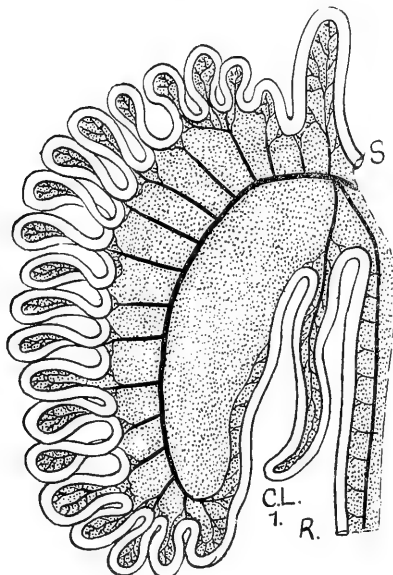
S. Cut end of the gut nearest stomach. R. Cut end of gut nearest rectum.
C. Cæcum. C.L.1. Colic loop (*ansa coli dextra*).

In *Erinaceus* and in *Centetes* (Mitchell, 1905, fig. 31), the duodenum and Meckel's tract are not distinct. The latter is arranged in very regular minor loops round the periphery of a nearly circular expanse of mesentery. There is no trace of a cæcum, or of a colic loop, but the recurrent limb runs up towards the dorsal middle line, and then bends over to form a short straight rectum.

In the three types the whole gut is suspended on a continuous mesentery, and the three appear to show stages in the attainment of a secondary simplification, the stages of which are, first,

the loss of the cæcum, next the obliteration of distinction between the fore-gut and the hind-gut, and the disappearance of the colic loop. I found no adventitious connections in any of the types, but I am unable to attach much importance to the presence or absence of these. Nor can I lay stress on the folding of the gut on itself; this is certainly present in *Macroscelides* and *Talpa*; Beddard states that it occurs in *Erinaceus*, and found it present in one example of *Centetes*, absent in another.

Text-figure 23.

Intestinal tract of *Talpa europæa*.

Lettering as in text-fig. 22.

The similarity of type between the pattern of *Macroscelides* (and probably of *Tupaia*, according to Flower and Hunter) and the pattern of *Phalangista*, recalls Dr. Broom's association of these animals with Diprotodont Marsupials and removal of them from the Insectivora (Broom, 1902, 1915). I must point out, however, that the pattern shared by the two is a very simple derivative of the primitive mammalian type, and on this ground alone, I would not be disposed to argue close affinity amongst the animals that display it. Moreover, if, as seems to me most probable, the colic loop of *Phalangista* resembles that of *Bettongia* and the Kangaroos, and belongs to the region of the hind-gut distad of the pendant loop, then the resemblance of *Macroscelides*

to Marsupials is not so close as to Monotremes. This is a point to which I had paid no special attention in 1905. Dr. Broom's conclusions are derived from investigation of the organ of Jacobson, and certainly the conditions that he has found appear to form a broader basis for systematic conclusions. I am not quite certain, however, as to whether or no he means to imply that the "Cœnrhinate" type of organ, which he finds to occur in *Talpa*, *Sorex*, *Erinaceus*, *Gymnura*, *Centetes*, and other normal Insectivora, as in Carnivora and Ungulata and most higher mammals, is a derivative of the more ancestral "Archæorhinate" type which he has found in *Tupaia*, *Macroscelides*, Diprotodonts, etc. If he means that the Archæorhinate type is the primitive type, and therefore to have been present in the common stock, the fact that it has been retained by certain forms is no conclusive argument for placing these forms together. As he finds it to occur in Monotremes, on the one hand, and in *Dasypus*, *Orycteropus*, and Rodents on the other, I suspect that it is, like the presence of a primitive gut-pattern, a character that must be used with caution in classification.

Without carrying further this question of breaking up the Insectivora, I may sum up by saying that the gut-patterns of the group start from an extremely simple type, and show successive stages of secondary simplification.

Order CHIROPTERA. *Rhinopoma microphyllum* (text-fig. 24).
Artibeus planirostris (text-fig. 25).

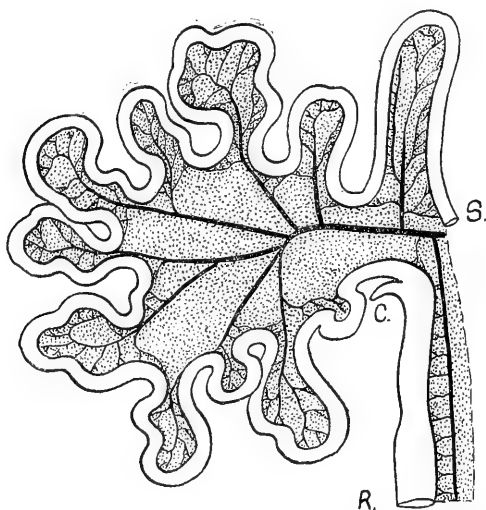
Since I wrote in 1905 I have had the opportunity of examining the intestinal tract in some other Bats, of which the most interesting was an example of *Rhinopoma microphyllum* (= *R. hardwickii*). The latter and *Megaderma spasma* were the two Bats in which Owen found a cæcum present (Owen, 1868, p. 429). In *Rhinopoma* the duodenal region is well separated from Meckel's tract. Meckel's tract makes up the greater portion of the gut, and consists of a number of very irregular minor loops, arranged so that they nearly complete the circumference of a circular expanse of mesentery, suspended by a narrow stalk to the mesentery of the duodenum in front and to that of the hind-gut posteriorly. In other words, the whole of the recurrent limb of the pendant loop is occupied by Meckel's tract, and it is only where it bends backwards to form the short and nearly straight rectal portion that the attachment of the cæcum marks the transition from fore-gut to hind-gut. The cæcum is short and conical. The hind-gut may be regarded as without a colon, but consisting merely of a rectal portion.

In the unexpanded condition, the subsidiary coils of Meckel's tract are irregularly folded over the mesentery so that they make up a large irregular mass visible as soon as the abdominal cavity is opened. The duodenum is also folded backwards, and cannot be seen until the mass of the fore-gut has been pushed

aside, whereupon it is visible, stretching backwards in close association with the rectum, but without secondary attachment either to that or to the mesentery of Meckel's tract. The primitive mesentery is retained along the whole length of the gut, quite unobscured by secondary attachments.

The position of the cæcum beyond the extremity of the pendant loop, and thus approaching the condition in most birds, especially the higher types of birds, is curious and very unlike the common condition in mammals.

Text-figure 24.



Intestinal tract of *Rhinopoma microphyllum*.

Lettering as in text-fig. 22.

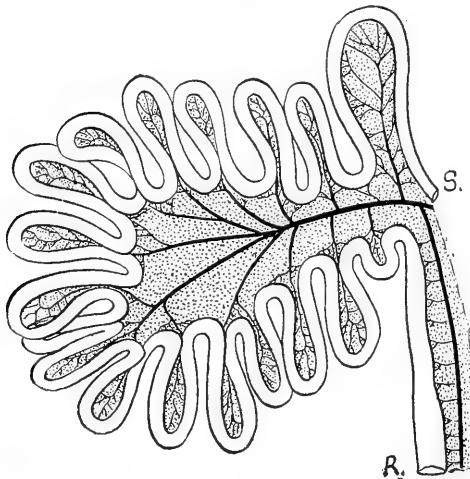
In the other Chiroptera that I have examined there was no cæcum, but the general form of the pattern when unfolded and the mode of arrangement in the undisturbed body-cavity were closely similar. The hind-gut was straight and relatively longer, its proximal end approaching very close to the duodenum. In most species the minor loops of Meckel's tract were irregularly folded and lobed as in *Rhinopoma*, but in *Artibeus* (text-fig. 25) they were relatively long (longer in proportion than in the diagram), and very straight. In the folded condition, the long straight loops, closely packed together and bent over from the edge of the mesenterial expanse to which they were attached, suggested a spiral conformation at first sight.

In an example of *Pteropus medius* that I have recently

examined, the duodenum consisted of two short loops marked off by their larger calibre. The proximal limb of the pendant loop and the beginning of the recurrent loop were thrown into long and very irregular minor loops, distad of which the recurrent limb had a straight course up to the middle dorsal line, where it bent round sharply to pass into the straight rectum.

In 1905 I had not seen an example of a Bat with a cæcum, and was content merely to point out the general similarity between the simple gut of Bats and of such Insectivores as *Centetes*, with the caution, however, that in neither case could it be asserted safely that the simplicity was primitive. I am now able to add

Text-figure 25.



Intestinal tract of *Artibeus planirostris*.

S. Cut end of intestine nearest stomach. R. Cut end of intestine nearest stomach.

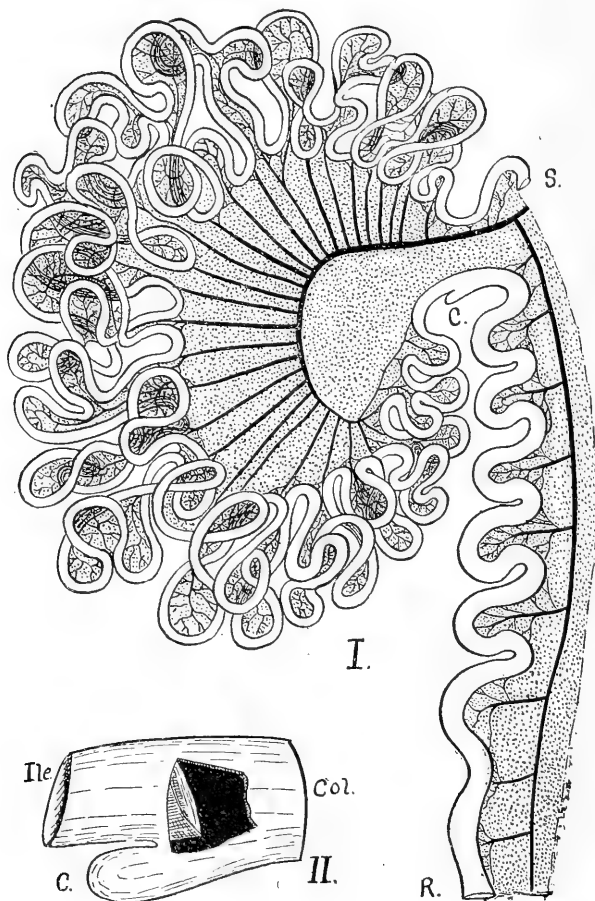
to the comparison. In Insectivores and Chiroptera the gut is relatively short, disposed on a continuous primitive mesentery, and in the extremest types shows little differentiation. In the Insectivores, however, the simplicity has been reached from a condition in which the cæcum was developed a considerable distance from the distal end of the pendant loop, and the upper portion of the recurrent limb possessed a large colic loop. In the Chiroptera, the whole of the pendant loop gives rise to Meckel's tract, the cæcum being placed distad of the passage of the pendant loop into the straight rectum. So far, therefore, as evidence is afforded by the gut-pattern, there is no reason to associate Chiroptera with Insectivores.

Order CARNIVORA.

Sub-Order Pinnipedia. *Odobænus rosmarus* (text-fig. 26). *Macrorhinus leoninus* (text-fig. 27).

The pattern of the intestinal tract of the Seals and their immediate allies is distinguished by simplicity, great length of Meckel's tract, reduction of the cæcum, relative shortness of the

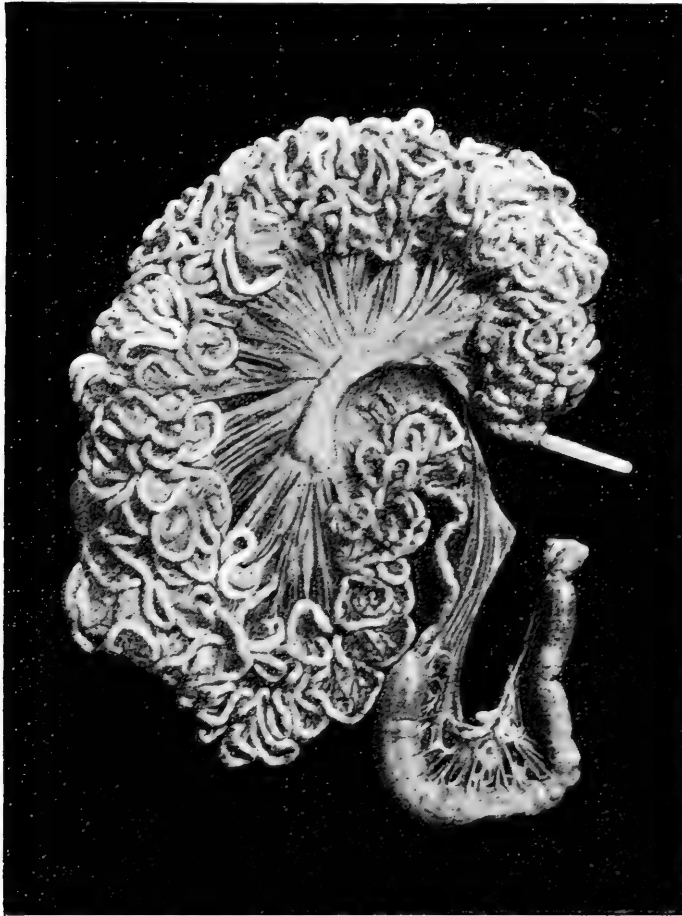
Text-figure 26.

Intestinal tract of *Odobænus rosmarus*.

- I. The tract as a whole. S. Cut end of gut nearest stomach. R. Cut end of gut nearest anus. C. Cæcum.
- II. Enlarged view of junction of ileum and hind-gut with cæcum. Ile. Cut end of ileum. Col. Cut end of colon. C. Cæcum. Part of the side-wall has been removed to show the protrusion of the ileum into the cæco-colic cavity.

hind-gut, and simple suspension from a continuous mesentery. In the Walrus (text-fig. 26) there is no clear separation of the duodenal region from Meckel's tract. The latter has an almost

Text-figure 27.



Intestinal tract of *Macrorhinus leoninus*.

From a photograph by Mr. D. Seth-Smith. A pocket-knife has been inserted into the cavity of the duodenum where it was separated from the stomach; the cut distal end of the rectum has been bent up towards the duodenum to bring it into focus.

even calibre throughout its length, and is very long (its length, although relatively less than that of the Elephant-Seal, has been rather under-estimated in the diagram). It is thrown into a

large series of irregular minor loops, nearly completing the periphery of an oval expanse of mesentery. The recurrent limb of the pendant loop also enters into the formation of Meckel's tract, and the short, rounded cæcum lies just where the pendant loop bends round at its highest point to pass into the hind-gut.

The distal end of the ileum projects through into the cavity of the hind-gut at an angle, the projection being much greater on the cæcal side. The cavity of the cæcum is, as is usual, a forward continuation of the cavity of the hind-gut. There is no transverse colon, the gut, at the highest point of the distal end of the recurrent loop, bending round sharply to the rectum. There is, in fact, practically no true colon, but the rectum is considerably longer than the course that it has to traverse, and is thrown into a number of minor loops.

I have recently had the opportunity of examining the intestines of a young Elephant-Seal (*Macrorhinus leoninus*). By the kindness of my colleague, Mr. D. Seth-Smith, I am able to reproduce as text-fig. 27 a photograph of the intestinal tract removed from the body and laid out to display its pattern. For this purpose, owing to the simplicity of the gut in this group and the absence of secondary connections, it was necessary only to sever the primitive mesentery that stretches from the duodenum to the rectum.

As in the Walrus, the duodenal region is not sharply marked off from Meckel's tract. The latter is of even calibre, and is thrown into extremely numerous minor folds arranged so as almost completely to surround an oval expanse of mesentery. Its length is enormous. The Elephant-Seal that I examined measured six feet nine inches from the tip of the snout to the tip of the tail: the small intestine measured with the tape, when the mesentery had been detached, one hundred and seventy-five feet six inches; the hind-gut was only two feet four inches long. When it has nearly reached the level of the duodenum, the distal limb, without any change of calibre, bends sharply round, and after a course of nearly a foot, suddenly changes in calibre. At this point there is nothing that can be called a cæcum, and it is doubtful whether the change from fore-gut to hind-gut can be placed accurately. If it is where the gut expands, then the position is quite abnormal amongst mammals: if, as in the Walrus, it is at the extremity of the recurrent limb of the pendant loop, then the sudden change of calibre in the course of the hind-gut, is also unusual. The hind-gut, after widening, bears an enlarged simple loop, which in the photograph is represented in an unnatural position; the distal end of the rectum was bent forwards to bring it into the picture. It appears to belong to the region distad of the pendant loop, and is an *ansa coli sinistra*.

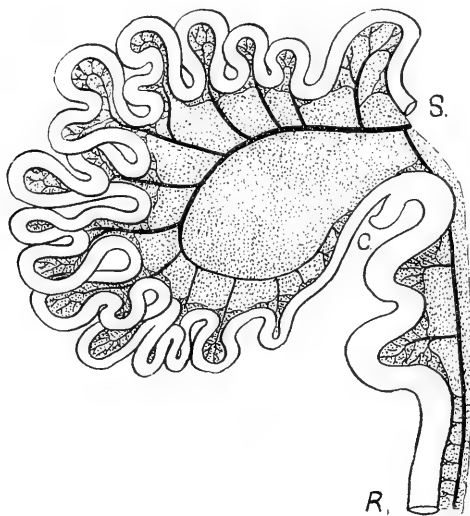
The gut patterns of the Walrus and of the Elephant-Seal do not differ notably from those of the Sea-Lion and of the true Seals that I have already described (Mitchell, 1905, p. 493, fig. 32).

The great increase in size of Meckel's tract, the position of the cæcum, if present, as is usually the case, close to the distal extremity of the recurrent limb of the pendant loop, and the presence of a distinct expansion of the hind-gut, although that is relatively short, are the most salient features. The pattern is quite different from that of the Manatee. It resembles the pattern of the Cetacean gut only in the extreme length of the small intestine; it differs notably in the position of the cæcum and in the hind-gut. As I shall show presently, it resembles closely the pattern of terrestrial Carnivora, the difference being chiefly the lengthening of Meckel's tract, which is best explained as an adaptation to diet.

Sub-Order Fissipedia. *Proteles cristatus* (text-fig. 28).

In 1905 I described and figured the patterns of the gut of a number of Fissipede Carnivora (Mitchell, 1905, p. 495, figs. 33 to 38) and have very little to add. I have had the opportunity,

Text-figure 28.



Intestinal tract of *Proteles cristatus*.

S. Cut end of gut nearest stomach. R. Cut end of gut nearest rectum. C. Cæcum.

however, of examining an example of the Aard Wolf (*Proteles cristatus*), an animal that is now seldom seen in menageries. So great is the uniformity of pattern amongst the terrestrial carnivores that *Proteles* may serve as an example of all. The duodenal

region is rather distinct from Meckel's tract. The latter forms the longest part of the gut, but is relatively shorter than in most types of mammals. It is thrown into rather simple minor loops which reach to the extremity of the proximal limb of the pendant loop, but in the recurrent limb are replaced by an almost straight portion running up towards the duodenum. The cæcum is situated high up on the recurrent limb, and in *Proteles* is short, although in the example I examined it was not so globular as was described by Flower (Flower, 1869), and had a slight spiral twist not noted by that author. The axis of the twist was connected with the distal extremity of the ileum by a very small fold of mesentery. The cæcum is frequently absent in Carnivores, but when present, and especially when it is relatively not very small, frequently displays a spiral twisting.

Distad of the cæcum the hind-gut bends round sharply, increasing in calibre and displaying a rather considerable expansion before it passes into the short straight rectum. The hind-gut is relatively short in all the Carnivores, and a notable feature is the reduction or absence of the transverse colon, the recurrent limb of the pendant loop bending round to pass backwards either with a very sharp turn, or at most a narrow sweep. From re-examination of all my original laboratory notes and drawings, I am disposed to think that at least in the great majority of Carnivores the expansion of the hind-gut, when present, belongs to the portion of the gut distad of the pendant loop, and is therefore an *ansa coli sinistra* not homologous with colic loops developed on the recurrent limb of the pendant loop.

In the Bears, however, as I have already shown (Mitchell, 1905, fig. 34), there is a definite colic loop present, and as this is an expansion of the recurrent limb of the pendant loop, it must be regarded as an *ansa coli dextra*. In the new-born cub of a Brown Bear, this loop was more definite and more elaborate than in the example of *Ursus malayanus* that I formerly figured. The Otter shows a somewhat similar condition. There was no trace of any secondary connection linking the colic region to the duodenum.

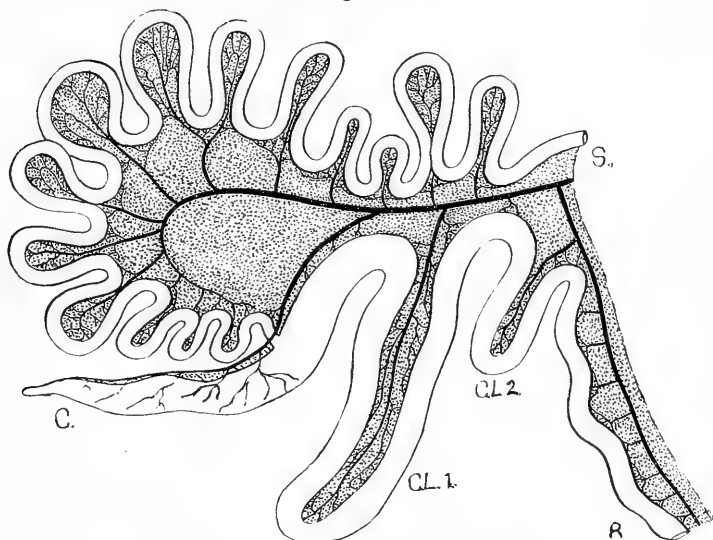
The primitive mesentery is retained in a nearly complete condition in most Carnivores, and in association with the relative shortness of the gut in the terrestrial forms, secondary attachments between proximal and distal portions of the gut appear to vary even individually, and never attain the physiological importance that they may be presumed to have in many other groups. As I have already stated, I do not believe them to have systematic importance.

It is clear that the Pinnipedes and Fissipedes exhibit gut-patterns that are fundamentally similar, although the resemblance is decreased by the adaptive lengthening of the gut in the aquatic forms.

Order PROSIMIÆ. *Chiromys madagascariensis* (text-fig. 29).
Lemur species? (text-fig. 30).

I have had the opportunity of examining an example of the Aye-Aye, and find that the pattern of the intestinal tract of that animal resembles extremely closely the patterns exhibited by the genus *Lemur*, much more closely than the patterns of other Lemurs. In this matter I completely confirm the conclusion of Dr. Beddard (Beddard, 1908, *Chiromys*). A comparison of the diagram of *Chiromys* (text-fig. 29) with that of a species of the genus *Lemur** (text-fig. 30) makes this resemblance plain. In

Text-figure 29.



Intestinal tract of *Chiromys madagascariensis*.

S. Cut end of gut nearest stomach. R. Cut end of gut nearest rectum. C. Cæcum.
 CL 1., CL 2. Colic loops (*anse coli dextra et sinistra*).

both the duodenal region is represented by two minor loops, which in the *Lemur* were marked by a much greater calibre. Meckel's tract was relatively rather short, and thrown into simple minor loops occupying the proximal portion of the original pendant loop, but not reaching far beyond it. The fore-gut enters at a right angle to the cavity of the very large cæcum which is in wide continuity with that of the dilated proximal portion of the hind-gut. In *Lemur* the

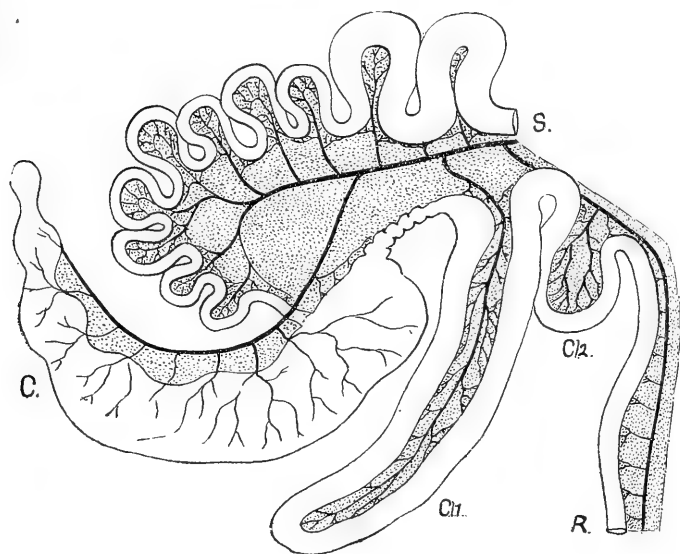
* The *Lemur* was an example of what has been called in the Society's Gardens. *L. brunneus*, the Black-headed *Lemur*, but the nomenclature of the *Lemurs* requires revision.

extreme distal end of the hind-gut was much expanded and was followed by a narrower portion strongly sacculated. I do not attach much importance to this; I have found the corresponding region sacculated, apparently as an individual peculiarity, in several examples of Lemurs and Monkeys, and Dr. Beddard (Beddard, 1908, p. 576) has recorded a similar but more extensive sacculatation in the case of a Baboon. The distal portion of the recurrent limb of the pendant loop gives rise to a long loop (C.L.1 in text-fig. 29, Cl.1 in text-fig. 30) of which the proximal and distal limbs are held together by a very narrow expanse of mesentery. This loop, lying just to the right of the representative of the transverse colon, corresponds with what is termed the *ansa coli dextra*. Its presence as a defined narrow loop is most marked in *Chiromys* and the genus *Lemur*. Dr. Beddard states that it is absent in *Microcebus* (Beddard, 1908, p. 579), and although I cannot agree with that author in making, in fact or in theory, so sharp a distinction between loops that are wide and loops that are narrow, I do agree that the *ansa coli dextra* is absent in *Chirogaleus*. Dr. Beddard also attaches importance to the fact that the *ansa coli dextra* is straight in *Chiromys* and *Lemur*, and spirally twisted in *Galago*, *Loris*, *Nycticebus*, *Indris*, and probably *Perodicticus*. As I have stated already in this communication, I cannot follow Dr. Beddard in attaching much importance to the presence of a spiral mode of packing any portion of the intestinal tract, unless this common growth-form attain a precise complexity. Nor can I agree that the spiral of Lemurs can be taken as the rolling up of a defined narrow loop. On reference to the original laboratory sketches from which the diagrams of the patterns of *Galago* and *Perodicticus* (Mitchell, 1905, figs. 41, 42) were made, and from further observations made since, I find that the loop in question may be very wide and irregular, presenting, when dissected out, a number of minor loops, as in at least one example of *Galago*, or two or more loops as in *Perodicticus*. These, however, are folded against each other and against Meckel's tract, and rudely twisted up. I agree, however, that it is possible to contrast *Chiromys* and *Lemur* with other genera possessing a well-marked *ansa coli dextra*, by saying that in the former the loop in question is characteristically narrow and straight, and in the latter that it tends to be spirally twisted. I should add to this, that in the latter it also tends to be wider and more irregular, and that the spiral twisting varies considerably in its extent.

Immediately distad of the *ansa coli dextra*, whether that be straight or twisted, the recurrent limb of the pendant loop reaches its highest point, and then, in the region corresponding with the transverse colon, sweeps backwards to form the rectum. The proximal portion of this gives rise, both in *Chiromys* and in *Lemur* (text-figs. 29, C.L. 2; 30, Cl. 2), to a well-marked loop neither so long nor so narrow relatively as the *ansa coli dextra*,

but forming an *ansa coli sinistra*. Dr. Beddard does not refer to this in the case of *Chiromys*, although it is indicated in his figure (Beddard, 1908, p. 150), but this omission is no doubt due to the fact that he does not recognise a loop as a distinct entity unless it has attained a certain degree of definiteness, and especially when it is "fixed" by some ligament other than its primitive mesentery. I apprehend that the expansion of the region of the hind-gut, just distad of the summit of the pendant loop in

Text-figure 30.



Intestinal tract of *Lemur* ? species.

Lettering as in text-fig. 29.

my figure of *Chirogaleus* (Mitchell, 1905, fig. 40), represents in a still less defined condition the *ansa coli sinistra*, and is not identical with the *ansa coli dextra* marked C.L. in figure 39 of the same communication. Burmeister's figure of the intestinal tract of *Tarsius* (Burmeister, 1846) is not easy to interpret, as the gut has been freed from the mesentery, but it seems probable that there is no trace of an *ansa coli dextra* or *sinistra* but a rather wide sweep representing a transverse colon. A figure given by Klaatsch (Klaatsch, 1892, pl. xxiii, fig. 8) confirms this interpretation. The rectal portion of the hind-gut in *Prosimiæ* runs a straight course to the anus, distad of the *ansa coli sinistra*, if that be present.

As Dr. Beddard has described, there are several secondary connections or ligaments in the intestinal tract of *Prosimiæ*.

These appear to me to vary considerably from individual to individual, but the most notable of them are an attachment of the omentum to the part where the distal limb of the pendant loop bends round to pass into the rectal portion of the hind-gut, and various attachments between the duodenum and the colon.

In 1905 I summed up the description of the gut-pattern in Prosimiæ as follows:—"The duodenum is seldom well distinct from Meckel's tract; the latter varies in length, probably in relation to diet. The cæcum is always present, and is usually very capacious. The hind-gut (except in *Tarsius*, where it is extremely reduced and still shows signs of former differentiation) is relatively extremely long, sometimes being as long as, or longer than, the fore-gut. It is, moreover, of greater calibre. It shows a well-marked colic region which may be a long narrow loop, or a complex set of folds, and a distinct rectum." I now add to this a few points. The duodenum is frequently marked off by its greater calibre. The hind-gut is much reduced in very small Lemurs such as *Chirogaleus* and *Microcebus*; in others it shows a definite *ansa coli dextra* developed from the distal portion of the pendant loop, usually long, narrow, and straight in *Chiromys* and *Lemur*, wider and more irregular and tending to be spirally twisted in at least most other genera. An *ansa coli sinistra*, shorter and usually wider than the *ansa dextra*, is frequently present on the proximal part of the rectum.

Order SIMIÆ.

I have no new observations to report, although I have examined a number of other Apes and Monkeys. For convenience I may quote my former summary (Mitchell, 1905, p. 515):—"The duodenum and Meckel's tract together form a series of loops which differ from group to group in their relative complexity, arranged round about three-quarters of the circular outgrowth of mesentery. The cæcum is always present and appears to have been originally capacious and of nearly equal calibre throughout its length; but it is in process of shortening throughout the group, being, as a rule, shorter in the Old World Monkeys than in the New World Monkeys and Anthropoid Apes (if in the latter case the vermiform appendix be reckoned with the cæcum). The state of the case may be put in another way. The originally long, capacious cæcum of the Simiæ is retained by the greater number of the Platyrrhine Apes; in the Catarrhine Apes, except the Hylobatidæ and Anthropomorphæ, it tends to become shorter without the formation of a vermiform appendix. In the two groups last named, its proximal portion has remained capacious, but the greater part of its original length has been transformed without shortening into the thick-walled vermiform appendix."

I should add to this that the presence of a rather well-pronounced transverse colon is the normal condition in the group,

and that the rectal portion is usually rather longer than the length that it has to traverse and is thus thrown into occasional minor folds. The colon presents no definite expansions that can be compared with the *ansa coli dextra et sinistra*, but the width of the transverse region suggests derivation from a condition in which both these loops were present. It is not difficult to see in the pattern of the Simiæ a condition that might have been reached by reduction from the Prosimian pattern.

General Conclusions.

In my earlier memoir (Mitchell, 1905) I dealt at some length with the inferences that seemed to follow from my observations, and I propose now to deal only with matters that call for addition or modification. It may be useful to say, in the first place, that the figures I gave formerly and those in this communication are, in the strictest sense, diagrams. That is to say, they are interpretations, not exact reproductions of the precise details of the individual specimens. So far as I know, they give a fair presentment of the significant features of the different patterns. They form, I hope, a good basis for intensive study of the details. It must be remembered, however, that I have attempted to represent the primitive continuous mesentery of the gut, and that, in actual fact, especially in the more elaborate types of intestinal tract, portions of this mesentery have disappeared. Notwithstanding the work of Klaatsch (1892) and others, much intensive study of individual types is still required to trace the precise portions that have been lost or retained. Moreover, I am certain that detailed study of the blood-vessels, after careful injection of fresh material, would yield useful results. It is well known that the mesenterial arteries and veins vary considerably in man, and doubtless this also is the case in other mammals. None the less, the general arrangement of the blood-vessels appears to me, on such slight study as I have been able to give, to follow the main morphological features of the gut-pattern, and in a number of cases where one region of the gut is difficult to distinguish from another, as, for instance, in the Bears, where there is no cæcum to mark the boundary between the ileum and the *ansa coli dextra*, the arrangement of the vessels in two groups clearly delimits the regions. I hope that in my diagrams the main features of the grouping of the blood-vessels are given, but very much more work than I was able to give is required.

The Cæcum.—Further work has confirmed me in the opinion that the cæcum of Mammals is one member of a primitive pair, homologous with the paired cæca of Birds. I have already sufficiently stated the facts that lead to this conclusion (Mitchell, 1905, p. 515), but I may refer to a curious side-light on the subject. *Baleniceps* is one of the few birds in which the normal

pair is represented by a single cæcum, and in this case it happens that the surviving cæcum is thin-walled and relatively capacious. If the figure of the cæcum of that bird (Mitchell, 1913, text-fig. 123) be compared with the normal unpaired cæcum of Mammals, it will be seen that the resemblance is very close.

Position of the Cæcum.—The most common position for the cæca in Birds is distad of the pendant loop on the straight portion of the hind-gut close to the cloaca. This position I associate with the progressive shortening of the hind-gut, which is a striking feature in avian anatomy as we turn from less specialized to more specialized types. In the lower types, in which the rectum is relatively longer, the cæca are placed more proximally on the hind-gut. In the Ostrich (Mitchell, 1896, fig. 4), for instance, where the fore-gut and hind-gut are more nearly equal in length, the cæca occupy a position almost identical with that of the paired cæca in the Manatee or the single cæcum of the Elephant. In no case, however, are they proximad of the distal end of the pendant loop. Among Mammals the most frequent position is about the middle of the recurrent limb of the pendant loop. It is a striking coincidence, however, that in the only Bat with a cæcum that I have seen, the position is so close to the distal extremity of the pendant loop, that it may be described as occupying an avian position. In *Tarsius* (according to Klaatsch, 1892, pl. xxiii. fig. 8) the cæcum is not at the distal end of the pendant loop. In the Carnivores, among which, as among Birds, there is a progressive degeneration of the hind-gut, the cæcum, although on the recurrent limb of the pendant loop, is very close to its distal extremity. In the Cetacea the other extreme is present; the cæcum lies almost at the proximal end of the recurrent limb of the pendant loop. The various positions of the cæcum in Birds and in Mammals nearly overlap, but the most frequent position in the one case is distad of the pendant loop, in the other somewhere on the pendant loop, a state of affairs congruous with the idea that the various conditions have come about by divergent modification from a common type.

Form and Function of the Cæcum.—I have nothing to add to my former discussion (Mitchell, 1905, p. 522). Only in a most general sense can there be said to be a correlation between diet and the presence, length, and capacity of the cæcum. There are many exceptions to any general statement, and it seems as if ancestral history were at least as potent a factor as actual diet.

Secondary Relations between Proximal and Distal Portions of the Intestinal Tract.—Two different kinds of connection may exist between proximal and distal regions of the intestinal tract. The connection to which I have paid most attention, and of

which I gave a long account (Mitchell, 1905, p. 524) was that in which blood-vessels belonging to one region of the gut supply another region with which it may be in contact, although morphologically remote. In Birds the folding of the gut brings the distal portion of Meckel's tract in close contact with the duodenum, and it frequently comes about that branches of the duodenal blood-vessels may form the main supply of the portion of Meckel's tract just proximal to the cæca, and may have to be severed before the whole gut can be unfolded. In Mammals the connection, when it exists, links the colic region to the anterior part of the gut. I wish to modify the table I gave only by omitting *Ornithorhynchus*; from examination of another example, I am far from certain as to the existence of a true "short-circuiting" blood-vessel, and the point could be settled only by examination of fresh injected material. The cases, then, in which this peculiar condition of the blood-vessels certainly exists are the Traguloidea, Tylopoda, Pecora, Rodents, Lemurs, and Simiæ. If one considers it, it is a curious circumstance that in the development of man a branch of the superior mesenteric artery should leave its normal course and thrust itself out to reach the transverse colon. Instead of explaining this as an instance of some marvellous coordinating vitalistic power, I prefer to think that it is a legacy from the past, and that the ancestors of the Simiæ had a more complex colon with loops pressed against the mesentery of Meckel's tract, as occurs in some of the Lemurs. In this connection it is interesting to note that Klaatsch found a Lemur-like stage of the colon in the embryo of *Hapale* (Klaatsch, 1892, p. 671, fig. 12, cited by Beddard, 1908, p. 598).

There are also connections of a more mechanical kind between different portions of the gut. These are the various "ligaments" and attachments to which I have frequently referred in this communication. They were not included in the table in my paper of 1905. Notwithstanding the elaborate work of Klaatsch (Klaatsch, 1892), and Dr. Beddard's later discussion (chiefly Beddard, 1908, p. 568 *et sequitur*), I cannot form a clear conception of the distribution of these structures among Mammals, and I have not myself made a connected investigation of them.

Loops of the Hind-gut.—I have already drawn a contrast between the gut-patterns of Birds and Mammals, depending on the broad fact that, even when allowance has been made for the homoplastic modifications associated with diet (Mitchell, 1905, p. 526), in Birds Meckel's tract and in Mammals the hind-gut tend to display specialized subsidiary loops of systematic importance. In Birds, however, the loops of Meckel's tract have reached a high degree of stability, so that they vary little within well-defined systematic groups, whereas in Mammals the loops of the hind-gut vary much more within narrow systematic limits, as if they were in much closer relation with habit or diet. The

facts do not seem to justify too close an identification between the specialized loops in one mammal and another. I propose, however, to give a tentative summary of the conditions.

In Monotremes there is an *ansa dextra* near the distal end of the pendant loop, and the rectum is straight.

In Marsupials the rectum is relatively long and may be thrown into minor loops. In the Polyprotodonts there are no other expansions of the hind-gut. In the Diprotodonts the usual condition is the presence of a complex *ansa sinistra*, and there may be in addition, as in the Phascolarctidæ, an equally complex *ansa dextra*.

In the Edentata the rectum is always relatively long; in the Pholidota there is no further expansion. In the Tubulidentata and Xenarthra there is also an *ansa sinistra*.

In the Hyracoidea, Sirenia, and Proboscidea the rectum is relatively long, especially in the region just distad of the pendant loop, and therefore forming an *ansa sinistra*.

In the Cetacea the rectum is straight, and there is no *ansa*.

Among the Ungulata vera, the rectum is always longer than the distance between the distal end of the pendant loop and the anus, and in the majority of the sub-groups the lengthening is most marked proximally, although, perhaps, not enough specialized to be regarded as corresponding with an *ansa sinistra*. An *ansa paracæcalis* or *postcæcalis* is present, just distad of the cæcum; in most of the Pecora, absent in the others, but its presence, in addition to the well-known colic spiral, makes it impossible to identify the latter with the paracæcal loop. The recurrent limb of the pendant loop always forms at least one large *ansa dextra*; this is complex in the *Hippopotamus*, and forms a spiral in the Swine, Traguloidea, Tylopoda, and Pecora, and a very long narrow loop in the Perissodactyla. In the Traguloidea, Tylopoda, and Pecora there is a second more distally placed *ansa dextra*, folded closely against Meckel's tract between the colic spiral and the minor loops of the tract.

In the Rodentia there is almost invariably a paracæcal loop often spirally twisted, with the cæcum or independently of it, always at least one and frequently two *ansæ dextræ*, which may be straight, or spirally twisted, together or independently, and pressed against Meckel's tract. An *ansa sinistra* is frequently present, either as a definite narrow loop, or as a complex loop, and the latter condition grades off into a wavy condition of the rectum, which in all Rodents is longer than the distance it has to traverse.

In the Insectivora the rectum is short and straight, but a definite *ansa dextra* is usually developed.

In the Chiroptera the whole hind-gut forms a short straight rectum, and there are no *ansæ*.

In the Carnivora the rectum, although relatively short, is usually longer than the distance it has to traverse (between the distal end of the pendant loop and the anus), and very often

presents minor loops at its proximal end, which may be grouped so as to form an *ansa sinistra*.

In the Bears there is, in addition, a definite *ansa dextra*.

In the Prosimiæ the rectum is always longer than the distance that it has to traverse, and at its proximal end, close to the distal extremity of the pendant loop, there is frequently a special expansion, forming an *ansa sinistra*. An *ansa dextra*, usually large in size, sometimes narrow, sometimes complex and almost doubled, sometimes straight and sometimes spirally twisted, is present in all except a few very small forms.

In the Simiæ the rectum is always longer than the distance it has to traverse. The proximal region of the hind-gut, composed of the pendant loop distad of the cæcum, the colic apex and the proximal portion of the primitively straight rectum are gradually approaching the human condition of nearly straight ascending, transverse, and descending colons, the appearances suggesting that this condition has been reached through a more prosimian stage in which there were definite *anse coll dextræ* and *sinistræ*.

Systematic Inferences.—In this section I propose to deal only with the facts to which I have myself paid attention. Unfortunately I am unable to follow, from Dr. Beddard's descriptions and figures, exactly what he means by the "stages of evolution of the intestinal part of the alimentary tract," and so cannot attempt to correlate them with my own results. Stage I. (Beddard, 1908, p. 591, text-fig. 120 A) represents a condition that is at least more primitive than in any known mammal. Two figures are labelled Stage II. (*loc. cit.*, text-figs. 120 B and 121), and differ in that the second figure shows rotation of the gut; but in each figure the so-called "cavo-duodenal ligament" is drawn and labelled, although in the text its existence is stated to be due to the rotation. In the later figures large portions of the gut are represented as without any mesentery, and much of the mesentery that is represented shows relations which I am unable to follow. Zoologists who wish to follow what is known as to the mode in which the rotation of the gut affects the primitive mesentery will find admirable descriptions and figures in the ordinary text-books (as, for instance, Professor D. J. Cunningham's 'Text-book of Anatomy,' 1902, pp. 1056, 1057, figs. 711, 712). Klaatsch (1892) is still the best authority on the secondary ligaments and attachments; but I cannot always follow him in the discrimination between portions of the primitive mesentery and secondary attachments, and suspect that much further investigation is required.

I am inclined to think, however, that rotation is due largely to simple mechanical causes, and that it is therefore an event that may have occurred repeatedly and independently, the resemblances caused by it being due not to inheritance from one ancestor in which rotation had occurred, but to a similar effect producing similar results on similar material. As Meckel's tract

lengthens, its closely bunched set of minor loops, developed chiefly on the proximal limb of the pendant loop, must push their way towards the middle line dorsal to the distal loop, which in primitive mammals hangs more freely down in the gut.

Taking only the characters presented by the gut-patterns as a basis, it appears that the most primitive or generalized type had a duodenum not well separated from Meckel's tract, Meckel's tract, consisting of minor loops developed along the proximal limb of the pendant loop, up to about the apex where the yolk-sac was attached, a moderately straight recurrent limb bearing towards the middle of its length a functional cæcum (or more probably a pair of functional cæca), a sharply bent colic flexure close to the duodenum, where the pendant loop passed into the rectal portion of the hind-gut; that rectal portion considerably longer than the length that it had to traverse, and thrown into specially long minor loops at its proximal extremity. Apart from rotation, the gut was suspended on a continuous primitive mesentery, and the blood-vessels supplied the regions of the gut to which they belonged. Changes from this primitive condition occur in two directions: the pattern may be secondarily reduced and become even more simple, or it may become more elaborate.

When characters are used for the purpose of classification, it may be convenient, in the absence of other information, to place creatures in the same group because they have retained ancestral conditions, but if the classification is intended to state the degree of affinity, then it must be remembered that there is no *a priori* reason to suppose that amongst the descendants of a common ancestor, the groups that have retained an ancestral character are more closely related than the groups that have lost it. On the other hand, the common possession of a well-marked elaboration of the primitive type appears to present some ground for implying affinity.

As in my summary of 1905, I associate the Marsupialia, Xenarthra, and Tubulidentata as displaying, on the whole, the most ancestral type of gut-pattern, with the proviso that this association does not imply close affinity but merely the retention of a common inheritance. I think it safer to exclude the Galeopithecidae from this association, as my information with regard to that Order is second-hand. I note with regard to the Marsupials, however, that they contain two departures from the ancestral type. In some of the small Polyprotodonts the gut-pattern is extremely reduced, with complete loss of cæca and obliteration of clear distinction between the different regions. In other Marsupials, such as the Phascolarctidae, the hind-gut has attained an elaboration recalling that of higher types. In the gut, as in many other parts of their structure, the Marsupials appear to forecast, on a lower level, and in a more fluctuating condition, elaborations that become definite and "fixed" in higher types.

As it is difficult to suppose that the different types of organs in higher Mammals have arisen separately from the corresponding types in Marsupials, we are faced with the possibility that organisms may have inherited the possibility of displaying definite variations that have not actually appeared in their ancestral history, a possibility which, as Arthur Willey has shown (Willey, 1911), has not yet been sufficiently considered in systematic zoology.

I have also to note that the characters of the gut-patterns afford no ground for grouping together the so-called Edentates.

It is interesting to note that amongst other primitive characters this first group of mammals contain abundant relics of what I take to be the primitive paired condition of the cæca.

The Monotremes have not moved far from the primitive type, but in a definite direction. The duodenum is distinct: the cæcum is single but degenerate, and is placed very close to the apex of the pendant loop, the distal limb of which displays a compound *ansa coli dextra*, and the rectal portion is relatively short and straight.

The Pholidota, although not far removed from the primitive type, have lost the cæcum, and have a longitudinally striated hind-gut which is unique.

The Hyracoidea, Sirenia, and Proboscidea have not moved far from the common type, and I realize that their association may depend very largely on their retention of primitive characters. In all, the primitive mesentery is very complete and continuous, and although the hind-gut is long, there are no specialized loops. The unpaired cæcum of Hyracoidea, if I am correct in refusing to identify it with the unpaired cæcum of other mammals, is a peculiarity unique among mammals; but apart from that, and taking the paired cæca as the true representatives of the normal structure, there is a very close resemblance between the pattern of Hyracoidea and that of the Manatee. The chief difference is the further increase of length of the hind-gut, distad of the pendant loop, in the Manatee. The Dugong is said to have a gut-pattern of the same type as that of the Manatee, except that the cæcum is single, and such a pattern leads directly to that of the Elephants, in which the cæcum is unpaired and the hind-gut thrown into long irregular minor loops, so that it appears to be almost as long as the fore-gut. There is no trace of any of the peculiarities of pattern found amongst the true Ungulata.

In considering the Cetacea, the first feature of importance is that the Odontocete pattern is most easily explained as a derivative by reduction of a pattern such as is found in the Mystacoceti. The Mystacocete pattern, although peculiar, is not very far removed from the primitive type, but the great elongation of Meckel's tract with the cæcum at its apex, the long, nearly straight, recurrent limb of the pendant loop, and the long but nearly straight rectum, make up a divergence from the

primitive type quite unlike the divergence found in any other group, and support the supposition that the Cetacea diverged from other Eutherians at a very remote period.

I am not now prepared to associate the Perissodactyla and the Artiodactyla on the evidence afforded by gut-patterns. Both groups may well have arisen independently from the common stock. In all the Artiodactyles there has been a great lengthening of the portion of the hind-gut formed from the distal limb of the pendant loop. In *Hippopotamus* this lengthening is irregular; in the Suidæ it forms a definite spiral. In the Traguloidea, Tylopoda, and Pecora this spiral reappears but gradually becomes more specialized and more intimately associated with the mesentery and blood-vessels of Meckel's tract. There may be another expansion of the same region proximad of the spiral, forming an *ansa paracæcalis*, and another distad of it forming a second *ansa coli dextra*.

In the Perissodactyla the whole of the recurrent limb of the pendant loop distad of the large cæcum gives rise to an enormous, narrow, *ansa coli dextra*, an arrangement quite different from that in any other group. It is certainly remarkable to find that the herbivorous Perissodactyles have developed a type of gut-pattern extremely like that of the herbivorous Artiodactyles, unless we are prepared to think that adaptation plays only a secondary part in the matter.

Among the Rodents we might expect to find convergent resemblances with Artiodactyles, but these are quite superficial. The mode in which the hind-gut is lengthened, the spiral twisting of the cæcum, its relation to the paracæcal loop, the frequent doubling of the *ansa coli dextra*, and the frequent appearance of an *ansa coli sinistra* compose a general picture quite different from that of the Artiodactyla or Perissodactyla. So far as gut-pattern is concerned, the Rodents may well have arisen as a distinct outgrowth of the primitive stock.

The gut-patterns of Insectivora are consistent with the conception that there has been a secondary reduction or simplification within the group from such a modification of the primitive Mammalian type as is seen in *Macroscelides*. The pattern of *Macroscelides* might belong to any simple Marsupial or Monotreme-like creature; it differs from the Marsupial patterns most closely resembling it, by the presence of an *ansa coli dextra* instead of an *ansa coli sinistra*, and from the Monotreme pattern in having the cæcum some distance from the apex of the pendant loop instead of very close to it.

The examination of one of the Chiroptera in which the cæcum is present has enabled me to distinguish between the very simple patterns of Insectivora and of Chiroptera. In Chiroptera the whole of the pendant loop becomes Meckel's tract, and the hind-gut is reduced to an extremely short and straight rectum. No doubt the bird-like shortening of the hind-gut is a secondary

divergence from the primitive type, but this would not affect the position of the cæcum, and quite certainly the gut-pattern offers no argument for any close association between Chiroptera and Insectivora.

The gut-pattern of Carnivores, notwithstanding the enormous lengthening of the fore-gut in the Fissipedia, has moved little from the primitive type, consisting of a fore-gut developed from the greater part of the pendant loop, and a hind-gut, which, although relatively short, is always longer than the length that it has to traverse and not infrequently presents an expansion that may be termed an *ansa coli sinistra*. The Bears are the only exception to the coherence of the picture; they have no cæcum, but the anatomical relations seem to show that their cæcum was originally placed much more near the proximal end of the recurrent limb of the pendant loop, and that the distal portion of that loop has given rise to an *ansa coli dextra* absent in the other groups. The true explanation may be that the apparent simplicity of the pattern in other Carnivores has come about by reduction.

The Prosimian pattern is not far removed from the primitive type, but tends to the development of at least one minor expansion of the recurrent limb of the pendant loop, an *ansa coli dextra*, which may be straight or spirally coiled, and there may also be an *ansa coli sinistra*.

The Simian pattern is best understood as derived from the Prosimian pattern by reduction.

If the gut-patterns were our sole source of information as to the inter-relationships of existing mammals, I do not think that we could get much further than is set forth in the annexed table, in which little stress must be laid on the vertical arrangement:—

	— Pholidota.	
	Monotremata.	
	{ Hyracoidea.	
	{ Sirenia.	
	{ Proboscidea.	
	Mystacoceti—Odontoceti.	
{ Marsupialia. Xenarthra. Tubulidentata.	{ Hippopotamidæ.	{ Traguloidea. { Tylopoda. Pecora.
	{ Suidæ.	
	Perissodactyla.	
	Prosimiæ—Simiæ.	
	Rodentia.	
	Insectivora.	
	Chiroptera.	
	— Carnivora.	

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DEVELOPMENT.	

Preface.

The following paper is the first part of a report upon the Anoplura and Mallophaga collected upon the Mammals and Birds that have died from time to time in the Society's Gardens, and kindly submitted to me for identification and study by the Zoological Society of London. On account of the opportunities for straggling on to other species of host afforded to ectoparasites on animals in a menagerie, the correct names of the hosts in some instances may be open to doubt, while the labour involved in the identification of the specimens is thereby much increased, particularly in two such groups as these, which in greater part remain in a state of considerable systematic confusion. In the present collection, however, I have come across very little evidence of straggling, and, in any case, such a contingency is amply compensated for by the fact that through the kind offices of the late Prosector, Dr. F. E. Beddard, F.R.S., and the Society's Pathologist, Professor H. G. Plimmer, F.R.S., much of the material has been fixed and carefully preserved in alcohol. It has thus been possible to add to the knowledge of many of the forms coming under review and to turn the report into something more than a dull census of names. The value of the systematist's routine work would be greatly enhanced if an endeavour were constantly made to add at least something, however small, to the pre-existing knowledge of the morphology of each species. The correct naming of an animal is the systematist's opportunity—too frequently neglected.

In entomology of late, those who observe the Heavens will have seen certain signs in the sky, one being the growing demand for spirit-specimens *pari passu* with the growing recognition that there is no group of insects in which a duplicate series of

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spirit-specimens is not essential for systematic study; while in many groups, such as those here considered and the Ephemeridæ, pinned or carded material is for the purposes of study almost worthless. Another portent is the obsolescence of the short, superficial Latin diagnosis in the description of new species—the persistent remains of the early influence of the schoolmen on systematic zoology. In some quarters the superficial diagnosis is already swept into limbo with the Sedan chair—both of them vehicles which could not possibly take us far, as traffic runs nowadays.

As *précis* work the superficial diagnosis is admirable. A certain number of characters from a certain restricted area of an animal's anatomy (as a rule, the easily accessible external parts) are selected and then welded into a cast-iron paragraph as exact and inflexible as a lawyer's deed-poll. But in entomology, as in politics, the lawyer is a strong but undesirable element, and the only justification for the superficial diagnosis is that the descriptive writer sometimes may find it convenient as a summary to tag on to the end of a long description.

The systematist is primarily a morphologist whose task it is to discover the true phylogenetic relationships, at least between the small subdivisions such as genera and species. This is a responsible task, especially in entomology, requiring the dissection, careful morphological examination, and description of each species. Many characters which have to be dissected to be seen are already in use among systematic entomologists, *e. g.*, the male genitalia, the spermatheca, the mouth-parts, and endoskeleton. It is not suggested, of course, that internal or concealed characters are necessarily better than external ones. What are the best characters for systematic use is a question which has to be investigated and settled for each individual group of the Animal Kingdom. Quite recently Dr. P. Chalmers Mitchell wrote * :—"The more experience I gain of avian anatomy, the more I am convinced that systematists are well advised when they rely, at least with regard to the discrimination of species and genera, more upon those superficial characters that they can observe in the series of museum collections than on the uncertain indications afforded by the presence or absence of this or that muscle."

Yet, how many systematists have conscientiously gone through the anatomy of their group with a view to settling this fundamental question of the best combination of characters for the purposes of classification (for I imagine that single-character classification, such as Huxley's palate and Garrod's ambiens among birds is now discredited). The descriptive writer is an opportunist who, as a rule, seizes upon the most *convenient* characters that offer themselves. Certainly, it is in entomological opportunism that we must seek the cause of the present systematic disorder among the

* P. Z. S. 1915, p. 413.

Anoplura and Mallophaga, for recent authors alone have agreed to treat these two groups from the morphological standpoint*.

Lest in the following essay it be urged, perhaps, that I have recked not my own rede, it must be explained that the amount of anatomical work which a systematist is able to accomplish on any one species is governed by the nature of the material—its quantity and quality. No attempt has been made to dissect species of which only one or two specimens were available, and in no case has it been possible to attempt the anatomy of the soft parts, as Part I. deals mainly with those specimens—in a poor state of preservation—which formed the nucleus of the collection handed over to me in the beginning from another worker who was prevented from carrying out the work.

ANOPLURA.

Genus *PEDICULUS* Linné.

PEDICULUS CAPITIS De Geer (1).

Piaget (2, p. 626) described as a new species of *Pediculus* a form taken on *Ateles pentadactylus* Is. Geoff. from the collection of the Museum of Leiden. *P. consobrinus*, as it was named, is so close to *P. capitis* that one searches Piaget's text and figures in vain for reliable distinguishing characters, and Neumann (3, p. 440) concludes that *P. consobrinus* cannot be clearly separated from *P. capitis*. Without Piaget's types before me, it is impossible to be certain about this, but that *P. capitis* does on occasion in menageries pass from man to monkeys is shown by specimens captured in the Gardens on the Red-faced Spider Monkey (*Ateles paniscus* Linn., Family Cebidæ).

PEDICULUS AFFINIS Mjöberg † (4, p. 169).

In large numbers on *Ateles paniscus* Linn. (Family Cebidæ) together with larvæ. In a lot distinct from the preceding.

Fahrenholz (5, p. 8) has described the larvæ of *Pediculus capitis*, with which the larvæ of *P. affinis* agree very closely, not only in the 3-segmented antenna, but in details of abdominal

* The whole question of the methods of research employed by the systematic zoologist is discussed in an anonymous paper published in 'The American Naturalist' for May 1914 (p. 369) entitled "Taxonomy and Evolution."

† This series of *Pediculus*, which undoubtedly belongs to the form named *P. affinis* by Mjöberg, proves on examination to be a very inconsiderable variety of *P. capitis*. Every one of the characters given by Mjöberg is inconstant and occurs occasionally, I find, on varieties of *P. capitis* from savage races. *P. affinis* is probably a straggler from human beings, establishing itself on *Ateles* on account of a certain similarity in the blood and hair between *Ateles* and the Anthropoids as adduced by Friedenthal. On this assumption the family Pediculidæ is, as far as known at present, confined to the Old World: the Pediculinae on Man and Apes, the Pedicininae on the lower monkeys. If it be held that *P. affinis* is a true parasite and at no time a straggler from Man, then, in view of the very general opinion that Platyrrhine and Catarrhine monkeys diverged very early from one another, this Cebid *Pediculus* would have to be regarded as a very remarkable case of convergence. The question will be fully dealt with in the 'Annals and Magazine of Natural History.'

chaetotaxy. Fahrenholz omits all reference to the larval chaetotaxy of the head and thorax, and it is therefore worthy of remark that, while the head and thoracic chaetotaxy (dorsal surface) of larvæ and adults are almost identical, the arrangement of the hairs on the ventral surface of these parts in the larvæ of *P. affinis* differs considerably, especially that of Stage I., from that of the adult in the same regions. On the dorsal surface the differences are negligible. But on the ventral surface of the head in Stage I. there are but two hairs (or bristles); in Stage II. there are four (two in front and two behind), and two minute hairs on each side in the preantennal area. The lower surface of the head of Stage III., as regards chaetotaxy, closely resembles the adult, except that the small group of hairs behind each antenna contains fewer hairs than in the group of the adult. On the ventral surface of the thorax there are fewer of the minute scattered hairs.

These facts are of some interest, being contrary to what has been found to obtain in the larvæ of three species of *Polyplax* (6, p. 271), where the chaetotaxy of the head and thorax is fully adult in Stage I., while that of the abdomen in the same stage agrees with *Pediculus* in presenting great differences.

Genus *PEDICINUS* Gervais.

Several species of *Pedicininae*, including one undoubtedly new form from *Colobus caudatus* Thos. (Family Cercopithecidae), are contained in the collection. But this group is difficult and in some confusion, and the Society's material is insufficient to justify any attempt to straighten things out. Fahrenholz's paper (5, p. 12) clears the way for a revision, which can best be effected by a study of the male copulatory apparatus.

Only the two following species have been definitely named :—

PEDICINUS RHESI Fahrenholz (5, p. 16).

A few specimens from *Macacus inuus* (now known as *Pithecus inuus* Linn.). Fahrenholz's specimens were obtained upon a "*Macacus rhesus*." Both hosts belong to the Cercopithecidae.

Genus *PTHIRPEDICINUS* Fahrenholz (5, p. 22).

PTHIRPEDICINUS MICROPS (Nitzsch) * (5, p. 25).

A single female from an unrecorded host.

Genus *POLYPLAX* Enderlein.

POLYPLAX SPINULOSA (Burm.) (7).

Numbers of specimens of this cosmopolitan species caught on the cosmopolitan rat (*Epimys norvegicus* Erxl.). The larvæ and

* [The parentheses around the names of authors placed after scientific names in this paper are used in accordance with Article 23 of the International Rules of Nomenclature (Proc. 7th Int. Cong. Boston, 1907, p. 44 (1912)).—EDITOR.]

the male copulatory apparatus are described and figured in the P. Z. S. 1915, pp. 256, 268, text-figs. 7, 15, 16).

Explanation of the Terminology used in describing the Male Copulatory Apparatus of Anoplura and Mallophaga.

In almost all Anoplura and Mallophaga, it is easy to recognise at once the basal plate and the parameres. The basal plate—probably double in origin as two longitudinal apodemes—is a chitinous lamina usually, if not always, longer than broad, to the posterior lateral angles of which are articulated the two chitinous appendages known as parameres. Between the parameres is the mesosome, the parts of which are not so readily made out unless a specimen be carefully dissected. Fundamentally, the mesosome is a sac—the enlarged and extrusible end continuous with the ductus ejaculatorius. This sac—called by Mjöberg “the preputial sac”—presents two regions of chitination—a distal and a proximal. At the distal end is the rod of the penis or virga, with frequently a splint on each side called the telomere, and one below—the hypomere*. At the proximal end are the endomeres, usually strongly chitinated bands or rods, one on each side, supporting the membrane of the sac, of which they are only local thickenings. The whole of the genitalia exhibit enormous variety in form, and the mesosomatic parts in particular are occasionally so much modified that it becomes difficult to recognise their conformation to the general plan just sketched out above. For example, in many Philopterids, such as *Docophorus*, no sacular portion of the apparatus is recognisable, and the distal chitinations lie well back within the proximal, the whole forming a solid and compact mesosome. The above terms are, therefore, adopted solely for convenience of description.

Genus *LINOGNATHUS* Enderlein.

LINOGNATHUS CAYLE-CAPENSIS (Pallas) (8, p. 37). (Text-fig. 1.)

The ample material of this species submitted provided the opportunity for a dissection of the copulatory apparatus of the male, which hitherto has been neither described nor figured. The accompanying text-illustration (text-fig. 1) makes it easy to dispense with a good deal of circumlocutionary description.

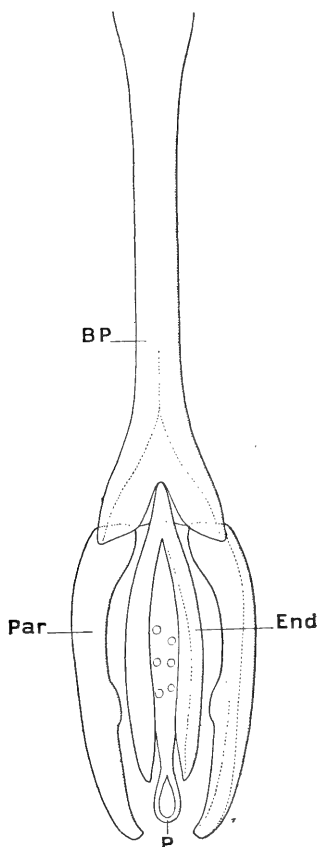
Basal plate: A fairly long and narrow rod, the posterior end of which, for the purpose of affording articulation to the parameres, is widened, and each posterior lateral angle drawn out into a short process, leaving the lower margin of the plate concave between.

Parameres: Each paramere at the base is fairly broad and fits in around the concave lower margin of the basal plate. Halfway

* For these terms, first applied to specialised Philopterid forms, see Waterston, *Annals of the S. African Museum*, vol. x. pt. 9, 1914, p. 279.

down on the inner side, each paramere shows a very pronounced thickening or nodule of chitin. At the extreme distal end the small acute termination of the paramere bends in sharply to face its fellow.

Text-figure 1.



Linognathus caviae-capensis. Male copulatory apparatus. $\times 378$.

BP. Basal plate; End. endomere; P. penis; Par. paramere.

Endomeres: These are fused at the base into a single piece. The two limbs support the "preputial sac," on the lower side of which, in the retracted condition, may be observed six large pustular alveoli, probably containing minute directive hairs or other form of sense-organ.

Penis: At the tip is an aperture, surrounded by a noose of chitin. This is probably the opening for the seminal fluid.

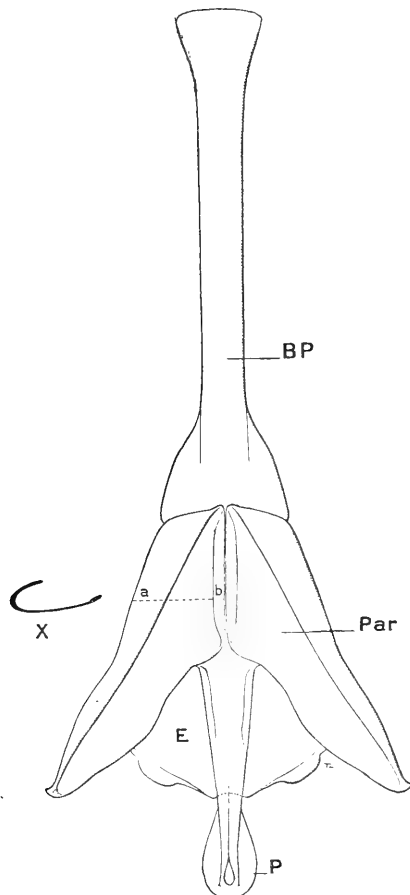
Telomeres: Not separately distinguishable.

The *hypomere* is in the form of a thin flat band, running back from the tip of the penis along the lower surface of the sac.

LINOGNATHUS LIMNOTRAGI Cummings (8, p. 36). (Text-fig. 2.)

Several specimens collected on *Limnotragus gratus* Scl. (Congo) and also on *Taurotragus oryx*.

Text-figure 2.



Linognathus limnotragi. Male copulatory apparatus. $\times 232$.

BP. Basal plate; E. endomere; P. penis; Par. paramere;

X. cross-section along the line a-b.

The parameres are dissected apart.

The following is a description of the male copulatory apparatus, unfortunately omitted from the original description:—

Basal plate: Rod-like, with an expanded posterior end; just

as in the preceding species. The posterior lateral processes, however, are less developed, and the posterior margin of the expanded posterior end is only slightly concave.

Parameres: These are of a remarkable type (text-fig. 2). Proximally they are broad blade-like pieces which meet each other (but do not fuse) beneath the mesosome in a fairly long median groove, then dorsally wrap themselves around the mesosome lying between them, forming a kind of sheath, from the end of which the penis projects, and, like the somewhat narrower distal ends of the parameres, curls up dorsalwards.

Penis: As in *L. cavie-capensis*, this ends in a loop-like aperture, of much smaller size, relatively. On each side of it may be discerned, under a high power, a small telomere, the three together forming a complex, running backwards into a broader basal part between the parameres.

The part "E" I regard as the endomeral part of the copulatory tube. These parts are reconsidered on p. 266.

LINOGNATHUS TIBIALIS (Piaget) (2, p. 646).

6 ♀ ♀ from an unrecorded host.

LINOGNATHUS GAZELLA Mjöberg (4, p. 157).

5 ♀ ♀ from an unrecorded host.

LINOGNATHUS PITHODES, sp. n. (Text-figs. 3-5)

2 ♂ ♂ and 12 ♀ ♀ from the Indian Antelope *Antelope cervicapra* Linn. Lucas described a variety of *L. tibialis* from the same host (Ann. Soc. Ent. France, 1847, p. 534).

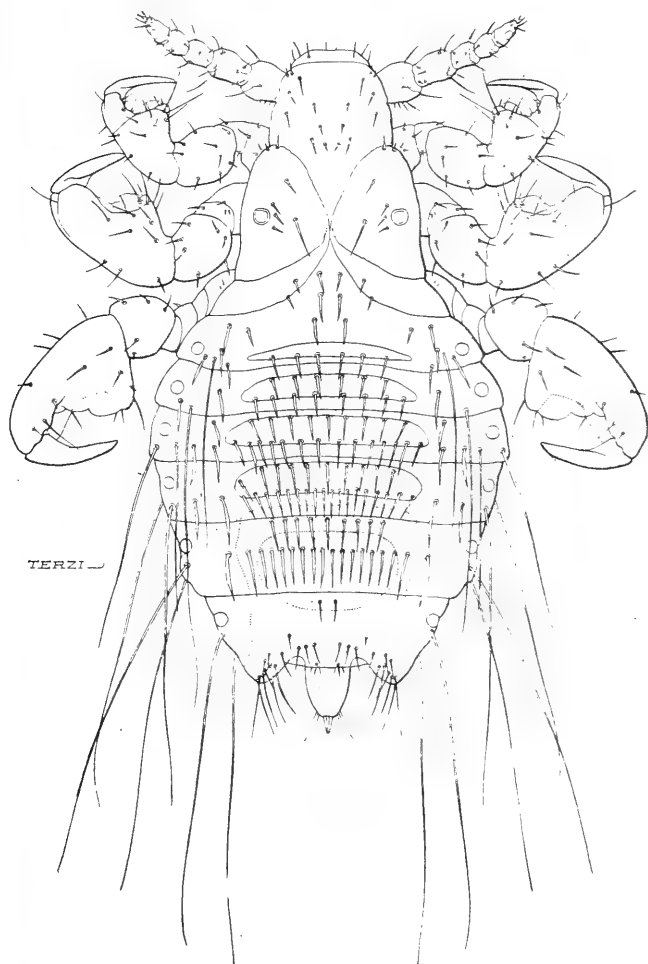
The species about to be described may at once be distinguished from all other members of the genus at present known by the presence on the abdomen of the male of a segmental series of tergites, each possessing a row of closely placed spines or "thorns," short and very thick, and set in a perfectly straight alignment (see text-fig. 3). The trefoil-shaped appearance of the posterior end of the abdomen in the male is also an obvious character for the species.

The genus *Linognathus* has hitherto been in part defined by the *absence* of abdominal sclerites; but, as in other respects the new species is typically linognathoid, it is better to expand the diagnosis of the old genus than to create a new one.

External Form. MALE.—A stout insect with a large tun-shaped abdomen. *Head*: Short and broad, almost as broad as long, extending only a little beyond the antennæ. In front the head is truncate and broad, the lateral angles rounded. Mouth opens ventrally in the middle of a circle of broad-banded chitin, the anterior semicircle of which runs across the dorsal surface of the truncate front of the head and then down on each side, the posterior semicircle being composed of thinner chitin. The post-antennal region of the head is a little broader than the

pre-antennal, and the two margins are parallel to one another. *Antennæ*: Elongate, graduated in width from the base to the tip (see measurements, p. 266). Cephalic apodemes as usual in *Linognathus* absent, the head fitting into a deep V-shaped cleft

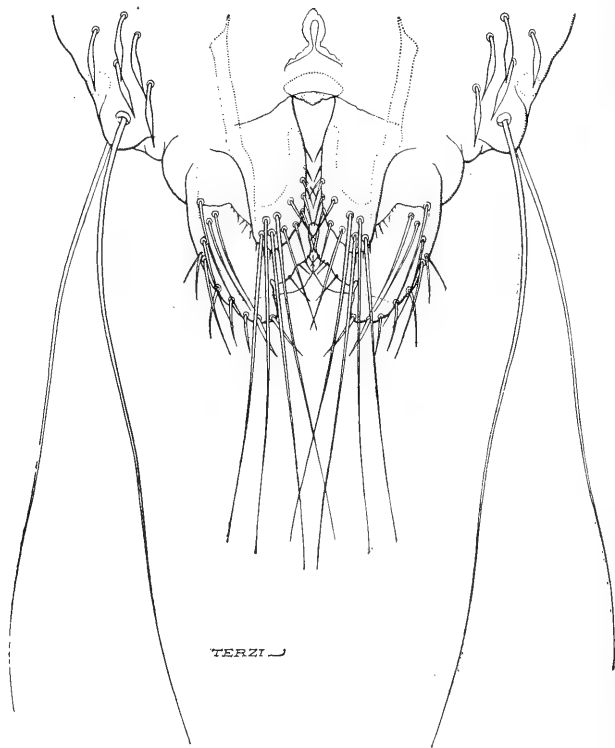
Text-figure 3.

*Linognathus pithodes*, ♂. × 68.

of the prothorax. *Thorax*: Broader than the head. Legs powerful, particularly the coxæ. The first pair of coxæ are large enough to reach forward on each side nearly as far as the

antennæ. The coxæ on the same side are contiguous, but widely separated from those of the other side. Femora short and very convex in the postaxial margin. *Abdomen*: Broad, globose. The tip of the copulatory apparatus projects from the tip of a long, stout, genital papilla shaped like a finger and terminating the abdomen. It lies between two smaller processes which project only a little, and are formed by the pleurites of the last segment. Dorsally there are five transverse strips of light brown chitin forming the tergite on each of segments 3 to 7, the anterior ones most clearly delimited.

Text-figure 4.



Linognathus pithodes, ♀. Ventral surface, showing gonopods. $\times 46\frac{1}{2}$.

External Form. FEMALE.—*Abdomen*: A little longer and narrower than in the male. Tergites absent. As in the female of *L. tibialis*, *L. fahrenheitzi* and others, the end of the abdomen is drawn out into a pair of processes, which in this species are quite short and project only a little beyond the terminal tergum.

The gonopods measure .2 of a millimetre in length and .09 wide, each with a strong chitinous external margin (text-fig. 4).

Chaetotaxy. MALE.—Remarkable for the presence along the abdominal tergites of a segmental series of perfectly straight transverse rows of closely placed spines—short, thick, and dark brown in colour. *Head*: Several well-spaced hairs on the chitinous circle around the mouth. *Dorsal surface*: hairs arranged as in the text-figure. *Ventral surface*: a stout hair on each side at about the level of the postaxial margin of the antenna. *Thorax*: A stout bristle on each side of the pronotum. The usual mesothoracic bristle; between it and the spiracle on each side three small spiny hairs. Two spines on the hind margin of the metanotum. *Abdomen*: The rows of modified short spines in straight alignment on the dorsal surface are given in the following table:—

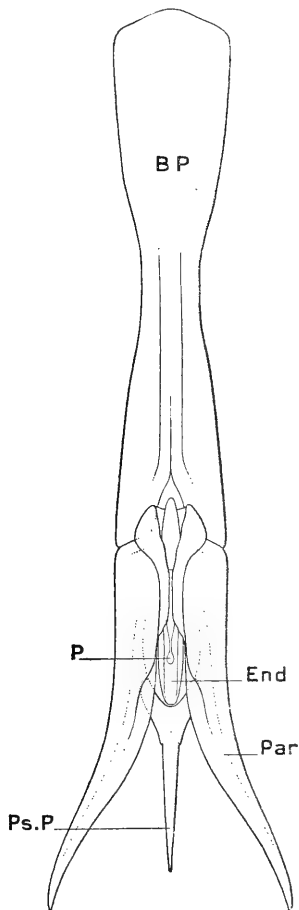
Segment 1	2
" 2	2
" 3	5
" 4	
" 5	8
" 6	
" 7	14
" 8	
" 9	9
" 10	
" 11	18
" 12	
" 13	9
" 14	
" 15	16

On the tergum of segment 8 are two bristles, while across the tergum of the terminal segment is a row rather difficult to observe of eight or nine small hairs which connect up with two small groups of hairs, one on each pleurite. On the pleuræ of each segment, dorsally, numerous scattered lanceolate spines. A pair of small hairs at the tip of the genital papilla. Other hairs as in text-figure 3. On the ventral surface the spines are mostly lanceolate in shape, more widely spaced and fewer in number, arranged in six rows. In the first and second there are four; in the third, eight; in the fourth, nine (the two middle ones being longest); in the fifth, twelve (the four middle ones being longest); in the sixth, ten (the four middle ones being longest and the lateral ones irregularly arranged). On the sternum of segment 8 there are two long bristles and a lanceolate spine on the inside of each pleurum.

Chaetotaxy. FEMALE.—*Head*: As in the male; but the hairs on the dorsal surface are stouter and longer. *Thorax*: As in the male. *Abdomen*: Both dorsal and ventral surfaces covered with a large number of stout lanceolate spines arranged in no definite pattern or order. On the tergum of the eighth segment, somewhat apart from the others, are two extra long hairs. On the eighth sternum, in the middle, just before the gonopods, are four elongate bristles in two pairs. Between the two couples is

a patch of minute hairs, ten in number. Tips of gonopods with several elongate bristles and a patch (situated chiefly on the dorsal surface of the gonopod) of smallish thin hairs. Pleura of segments 3 and 4 with a single long bristle each. Those of segments 5, 6, 7, and 8 each with two.

Text-figure 5.



Linognathus pithodes. Male copulatory apparatus. $\times 178$.
The parameres have been pulled apart.

BP. Basal plate; *End.* endomere; *P.* penis; *Par.* paramere;
Ps.P. pseudo-penis.

Coloration.—The thicker parts of the exoskeleton are of a warm brown colour, as, for example, the band on the anterior

margin of the head, the "thumbs" and claws of the second and third pairs of legs, and also at the extremity of the abdomen in the bays, one on each side of the base of the finger-shaped genital papilla in the male. The tergites are of a light brown colour, and each antennal segment is similarly banded. Across the distal broad part of the tibiæ of the front legs is a comparatively narrow, transverse, brown band. Coxæ of a uniform deep brown colour.

Male Copulatory Apparatus (text-fig. 5).—*Basal plate*: Broader than the plate in the two preceding species of *Linognathus*. At the base it is slightly bifid, each short limb being a process for the articulation of a paramere. A suture is observable in the median line of the plate, extending from the cleft between the two basal processes up to just beyond half the length of the plate. This groove or suture, which indicates the originally double nature of the plate probably throughout the Order, lies in a narrow thickening in the mid-line of the plate, on each side of which the chitin is flattened and thinner. At the upper end the plate is of a uniform thinness and is a little broader. *Parameres*: These are long, narrow, and tapering to an acute apex. Towards the base each paramere develops on its inner side a kind of supporting ledge or shelf which runs in below the mesosome. The outer side becomes thickened and turns in almost at right angles on arriving at the basal plate, with the limb of which on each side of the cleft it is connected. *Penis*: Although it is impossible to speak definitely when the apparatus is in the retracted state, I think it is fairly safe to assume that the loop-like apertures marked *P* in text-figs. 1, 2 & 5 are homologous. Now, in *L. limnotragi* this aperture obviously lies at the tip of the penis, whereas in the present new form it is seen lying within the chitinous bars marked *End*. It may therefore be supposed that the distal end of the penis-tube with the aperture is here telescoped into the firm chitinous base, which may be either endomeral or the base of the penis. The pseudo-penis (*Ps.P.*) is also probably an endomeral chitination.

Measurements (millimetre scale).

	♂.		♀.	
	Length.	Breadth.	Length.	Breadth.
Head	·29 (median)	·20	·35 (median line)	·17
Thorax	·22	·30	·30 (lateral margin)	·35 (at base)
Abdomen ..	·80	·64	·85	·65
Total	1·31		1·50	

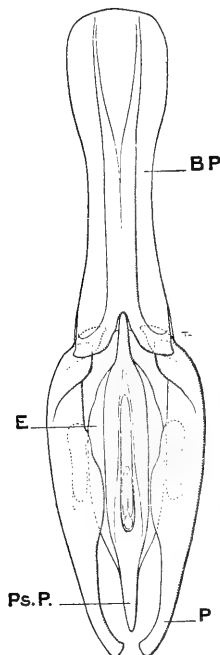
Antenna of male.

	Length.	Breadth.
Segment 1	·064	·080
" 2	·076	·056
" 3	·050	·040
" 4	·040	·040
" 5	·044	<div style="display: flex; align-items: center;"> <div style="font-size: 3em; margin-right: 5px;">}</div> <div> ·038 (at base) ·032 (at tip) </div> </div>
Total	·274	

*Comparison with the Male Copulatory Apparatus in
Linognathus from Eland.*

Subjoined, with a discussion, is a description of the male copulatory apparatus of a new variety of *Linognathus tibialis*

Text-figure 6.



Linognathus tibialis. Male copulatory apparatus. $\times 140$.
BP. Basal plate; E. endomere; P. paramere; Ps.P. pseudo-penis.

from an Eland in the Zoological Gardens at Edinburgh. It is interesting to include a description and figure of the Eland *Linognathus* here for the purpose of comparison.

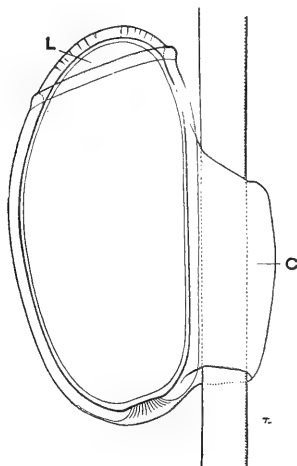
Basal plate: This closely resembles the plate of *L. pithodes* in the bifid lower end, the median suture, and median raised strip. *Parameres*: Proximally broad and fitting around the mesosome closely, a feature in which they resemble those of *L. limnotragi* (which wrap in around the mesosome extensively) and *L. pithodes*, in which there is a broad leaf-like shelf (see p. 264). They resemble *L. cavie-capensis* in the possession on the inner concave surface about halfway down of an area of thickened chitin, longer than the so-called "nodule" in the Procavian *Linognathus*. The appearance suggests, in both instances, a strengthening of the middle part for clasping the mesosome. *Mesosome*: As in *L. pithodes*, a pseudo-penis is present and fused with the rest of the endomerai chitination (text-fig. 6). A thin ledge of thin chitin runs along the outside of each of the two parallel bars. Between them lies the aperture and what I interpret as the true penis.

Genus HYBOPHTHIRUS Enderlein.

HYBOPHTHIRUS NOTOPHALLUS (Neumann) (8, p. 44, and 9). (Text-figs. 7, 8.)

Eggs, larvæ, and adults, male and female, from *Orycteropus afer* (Pall.).

Text-figure 7.



Hybophthirus notophallus. Egg.

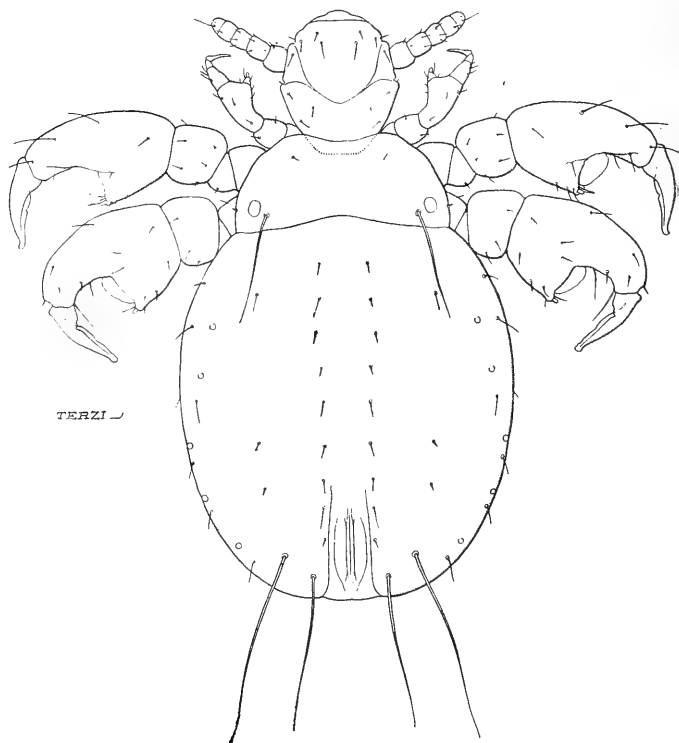
C. Cement; L. lid. $\times 36$.

Both Enderlein and Neumann (see 8, p. 44) have described this isolated louse-form; but Neumann's description is much the fuller, and includes a figure and description of the male

copulatory apparatus. The Society's specimens agree *in toto* with those described by Neumann. In Enderlein's figure there is a discrepancy in the metanotum which I do not understand.

I have re-examined the male copulatory apparatus and the following description supplements Neumann's and brings the parts under recently devised terminology. *Basal plate*: Fairly long and broad, broader in front than behind. The broader anterior end is somewhat spatulate, the concave side facing

Text-figure 8.



Hybophthirus notophallus. Larva, Stage I. $\times 39$.

dorsally. *Parameres*: Strong, fairly straight rods. They bulge a little and then immediately narrow before the tip. The tip is short and turned outwards. *Mesosome*: The parts between the parameres are merged into a single structure, in which the following parts may be distinguished:—Two bars, one on each side (probably the endomeres), and apically a triangular plate—the pseudo-penis. On the dorsal surface, projecting from about the level of the distal ends of the endomeres, is a small median

chitinous papilla, which is probably the *penis*. The larger distal end of this papilla is supported on each side by a chitinous margin—these latter parts, lower down, running into one another and forming a narrow neck.

The egg is shown in outline in text-fig. 7. The egg is large and fastened to the hair by a very strong thick cement along a straight inner surface, equal almost to two-thirds its total length. The shell and the lid are quite smooth. The micropyle apparatus on the lid consists of a number of very minute canals, which do not, as in many Anoplura, project as papillæ on the lid. Length 1.5 mm.; greatest width .72 mm.

Larva, Stage I. (text-fig. 8).—Head is very rounded. Abdomen without sclerites, ovate, smooth margin all the way round. Thorax with straight hind margin. Almost bald, except for two mesonotal hairs and two long hairs on each side of the last segment of abdomen. Other minute hairs as shown in the text-figure. Described from a single specimen.

Measurements (millimetre scale).

	Length.	Breadth.
Head .....	.40	.38 (behind antennæ)
Thorax .....	.40	.72 (at base)
Abdomen	1.20	1.02
Total	2.60	

Length of antenna33 mm.

MALLOPHAGA.

Genus BOOPIA Piaget.

BOOPIA TARSATA Piaget (2, p. 599). (Text-fig. 9.)

Twenty-two specimens from *Phascolomys mitchelli* Owen. Piaget's specimens were taken on a *P. fossor*.

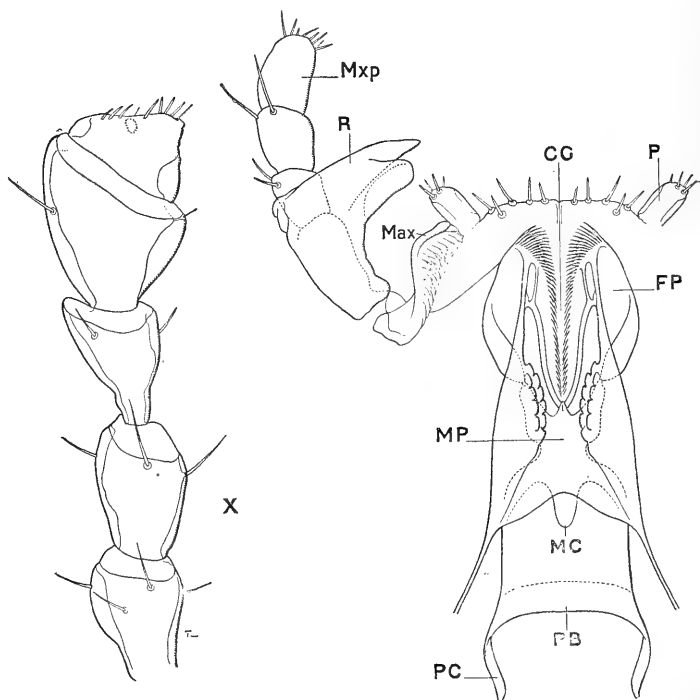
In all the males the copulatory apparatus was unfortunately retracted. It is practically impossible to draw out these parts in a dead specimen, and in our present state of knowledge very unsafe to describe such a complex structure as they present so long as they are withdrawn within the abdomen.

Mouth-parts.—A brief reference to the œsophageal sclerite in *Boopia* is made in my paper in the P. Z. S. for 1913, p. 138. The following description confirms the statement there made and extends it, all parts of the mouth being passed in review.

The text-figure includes the antenna (text-fig. 9). Between

the so-called paraglossæ the front margin of the *labium* is a little concave in the middle and somewhat swollen on each side at the base of each paraglossa. Each swollen patch carries several small spiny hairs. *First maxillæ*: For the palpi, see text-figure. The *lobes* are twice as long as broad. The inner surface densely studded with small curved hooks, those at the distal end longest. *Mandibles*: The *right* mandible is roughly quadri-lateral, the two distal lateral angles being formed by two distinct

Text-figure 9.

*Boopis tarsata*. Mouth-parts. $\times 300$.

CG. Ciliated groove; FP. fringed plate; MC. median cornu; MP. main plate of lyriform organ; Mxp. maxillary palpus; P. paraglossa; PC. post. cornu; PB. post. band; R. right mandible. X. Antenna.

apices—one acuminate, the other broad and rounded—separated from one another by a bay. The *left* is less powerful, with two acuminate apices—one alongside the other, and one a little longer than the other. *Isopogometric apparatus*: The text-figure shows the peculiarly complex framework on which this apparatus is held together. The main plate of the pharyngeal sclerite bears a curious resemblance to the sternum of such a

Ratite bird as *Dinornis* or *Apteryx*. The posterior lateral pieces are produced some way backwards and join on each side a transverse band. From each end of the transverse band a posterior cornu coils upwards on each side of the pharynx. The plate also has a posterior median process and two anterior lateral processes. The latter run forward and each gives articulation to a chitinous strip which bends round at the mouth and there forms the double fringed plate. Forwards, from the pharyngeal plate between the two anterior processes, two strong narrow cords run, forming between them the "ciliated groove," but diverging and eventually curling around posterior to the fringed plate on each side, so as to turn back into a broad, somewhat indefinite sheet of rather thin opaque chitin set with teeth.

Genus TRICHODECTES Nitzsch.

TRICHODECTES BREVICEPS Rudow (11).

8 ♀ ♀ from *Lama glama* L. (Family Camelidæ). Rudow's descriptions are notoriously bad, and are, as a rule, insufficient even for identification purposes. I prefer, however, to refer these female specimens to his species for the present, rather than describe them as new.

TRICHODECTES PARUMPILOSUS Piaget (2, p. 397).

Two immature specimens from *Cervus xanthopygus* M.-Edwards, I refer very doubtfully to this species.

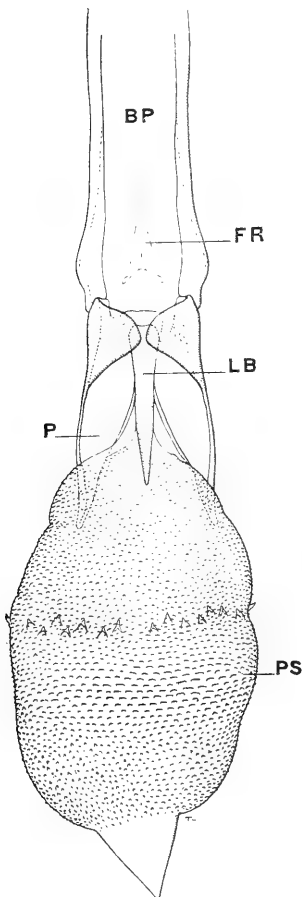
TRICHODECTES LATUS Nitzsch (10, p. 53). (Text-fig. 10.)

Twelve specimens, including males, from *Canis latrans* Linn.

Male Copulatory Apparatus (text-fig. 10).—*Basal plate*: The outline is shown in the figure. The lateral margins are strongly developed rods, the main body of the plate between being concave, so that the whole plate is of a trough-like form. At its anterior end the plate is rounded and the chitin becomes opaque and the outline indefinite. *Parameres*: At the base these are broad and leaflike, folding around the mesosome so as to form a sheath. The margins of the parameres almost meet each other over the dorsal surface at the base and similarly over the ventral surface. The *sac* is shot out between the parameres and is covered with denticles. One-half of the distance from its extremity is a transverse row of about eighteen, triangular denticles, larger than the rest, and functioning probably as retinacula. On the dorsal surface the base of this sac is strengthened by a flat lanceolate splint of chitin, with a broader base (at the lower margin of the basal plate) and a much narrower distal end towards the tips of the parameres. When the apparatus is retracted, this lanceolate band at about halfway is bent downwards and back upon itself, so that in side view it appears as an enigmatic loop. Between the two lateral margins, in the clear-

space at the base of the plate, may be seen a small forked rod, the fork pointing forwards. I am unable to say definitely whether this is the penis-rod attached to the end of the extrusible sac, or whether it is merely a median chitination of the basal plate.

Text-figure 10.



Trichodectes latus. Male copulatory apparatus. $\times 200$.

BP. Basal plate; *FR.* forked rod; *LB.* lanceolate band (endomer);
P. paramere; *PS.* preputial sac.

TRICHODECTES CRASSUS Nitzsch (10, p. 53).

Eighteen specimens from the Common Badger (*Meles meles* Linn.).

The male copulatory apparatus of this species agrees very

closely with that of the preceding species. *T. pinguis* N. also presents a close resemblance in the male genitalia to *T. latus*. In a revision and splitting up of this large and unwieldy genus, these are facts which should be borne in mind. (Concerning this subject, see also p. 283.)

TRICHODECTES CORNUTUS Gervais (12).

One female and two larvæ from *Gazella euchore*, now known as *Antidorcas euchore* Zimm. Gervais's specimens were collected on *Antilope dorcas*. Taschenberg (13, p. 220) identifies the species with Rudow's *T. longiceps* (11, p. 110), taken on *A. arabica*. Neumann (14, p. 626) records it from *Hippotragus equinus*. But, as Piaget remarks, the species requires to be examined again and described with more care.

TRICHODECTES HEMITRAGI, sp. n. (Text-figs. 11, 12.)

The material on which the following description is based consists of 13 females from the Tahr (*Hemitragus jemlaicus* Ham. Smith).

This new parasite is of considerable interest, on account of certain features in the anatomy of the mouth-parts, which are figured and detailed below. It is sufficient here to say that the pharyngeal sclerite or lyriform organ, upon superficial inspection apparently absent, proves on dissection to be present, but in so highly modified a form, that it must be considered unique in the Trichodectidæ so far examined, while it diverges greatly from the typical form of the organ in the Mallophaga as a whole (compare text-fig. 12 with text-fig. 16). This is the more interesting, as *T. hemitragi* ♀ is unmistakably a Trichodect, and presents, with this exception, no particularly novel characters. The male, however, is yet to be discovered, and may prove to rank as a distinct genus.

In examples of *Docophorus bisignatus*, from the Storks and Ibises, I have pointed out an instance (20, p. 134), very similar to the present one, of an abrupt deviation in the form of the œsophageal sclerite from that of the rest of the Mallophaga, where, particularly in *Docophorus* and *Trichodectes* and in the Ischnocera generally, it presents a fairly uniform appearance.

It would be premature to discuss the reason for this fundamental change in the character of this organ, occurring so abruptly among forms not otherwise anomalous, until our knowledge of the function of the isopogometric apparatus is more exact and fuller. But it is, in any event, a very remarkable fact.

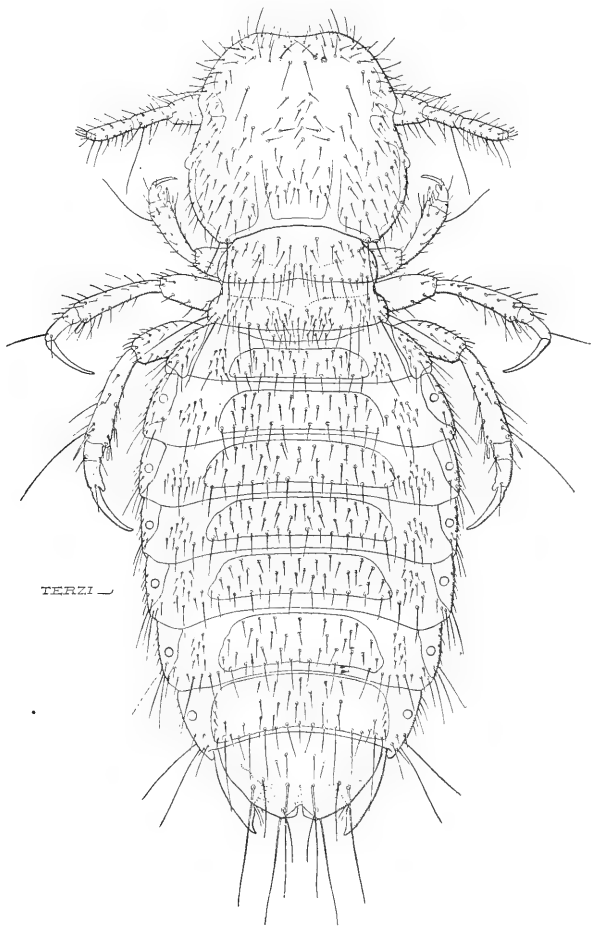
It may be pointed out that the pharyngeal sclerite is an internal organ, and in both the cases mentioned above is invisible without dissection. In these instances, therefore, a purely superficial diagnosis could only have resulted in the omission of an important and deep-rooted morphological difference—a character which, if external, would probably entitle the

species to generic rank, in the opinion of most of the systematic workers in this Order.

The following is a description:—

External Form (text-fig. 11). FEMALE.—*Head*: Preantennal area quite short. No frontal sinus, front margin straight or

Text-figure 11.



Trichodectes hemitragi, ♀. $\times 55.5$.

very slightly concave, with a narrow marginal band. Inferior "hair-canal" absent or obsolete. Temples very rounded and swell outwards behind the eye, making the head a little broader behind the antennae than in front. Dorsally, two occipital

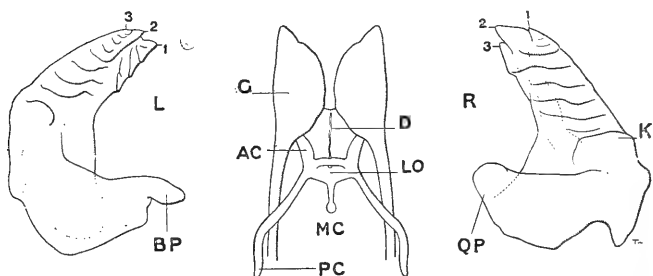
bands as rafters of the skull run forward towards the mandibles, and are straight and parallel to one another. In front of each antenna is a fairly large incassation, rounded in form and connected by a narrower neck with the margin. *Thorax*: Narrower than the head, with straight metanotal margin and convex lateral margin. *Abdomen*: Broader than the head, elliptical. A brown band on the dorsum of the segments, those on 5, 6 and 7 being the deepest in colour and in length. *Gonopods* (see text-fig. 11).

Chetotaxy. FEMALE.—*Head*: Dorsal surface covered with a great many fairly short hairs. Antennæ also set with a great many hairs, long and short, including one long one preaxially and a row of four long ones dorso-postaxially in segment 2, and on segment 3, along the postaxial margin, a straight row of six fairly long hairs. Ventrally, postantennal area appears to be quite bare. On the preantennal area there are numerous long bristles between the antenna and the frontal margin. *Thorax*: Dorsal surface set with small bristles, arranged as shown in the figure. *Abdomen*: Dorsal surface covered with bristles, long and short, which it is possible roughly to analyse into three transverse rows on each segment. There is, however, a small bare area inside each pleurite. Each pleurite carries numerous small hairs and two long ones, which are particularly long in segments 6 and 7. Dorsum of last segment almost bare, except for four or five long hairs in a widely-spaced transverse row. Ventral surface thickly covered with hairs, there being a particularly dense patch between the gonopods. At the extreme end of the abdomen there are two long bristles dorsally and two ventrally.

Mouth-parts.—Although the hair-canal in front of the mandibles may be said to be absent, it is indicated on the ventral surface by a difference in the thickness of the chitin of the margin. *Mandibles* are large and strongly ridged, the right one in almost its whole breadth lying behind the left, far forward near the front margin of the head. On the *right* one are three distinct apices, the middle one being the longest. At the base it runs in as a stout quadrangular process (text-fig. 12). Opposite this and on the dorsal surface is a large knob of dense chitin. The *left* mandible has three apices, two of which are very small and close together, and the usual narrow basal process. The transverse ridges are particularly strong, prominent, and downwardly directed at the base of the ventral tooth. Ridges are continuous in both mandibles across the surface of the mandible. *First Maxillæ*: These do not call for particular remark. *Labium*: Front margin straight with a small, short, squat paraglossa at each lateral angle. *Isopogometric Apparatus*: The pharyngeal sclerite or lyriform organ is a slender and delicate piece of chitin, consisting of two large sprawling posterior cornua, a prominent median cornu between these, a small and insignificant "nucleus" or main body, and two anterior cornua rather broad and long. The chitinous chord or duct, as usual, runs forward

and bifurcates, each branch entering a "gland" or basal piece. The latter has a short posterior tendon attached to it.

Text-figure 12.



Trichodectes hemitragi. Mouth-parts. $\times 166$. Labium not shown.

L. Left mandible. R. Right mandible. $\times 120$.

BP. Basal process; D. duct; G. "gland"; K. knob; LO. lyriform organ; PC, MC. AC. posterior, median, and anterior cornua; QP. quadrangular process; 1, 2, 3. apices.

Measurements (millimetre scale), ♀.

	Length.	Breadth.
Head	·50	·52 (behind antennæ)
Thorax	·28	·45
Abdomen	1·10	·84
Total	1·88	

Length of Antenna:—

Segment 1	·070
„ 2	·100
„ 3	·120
Total	·290

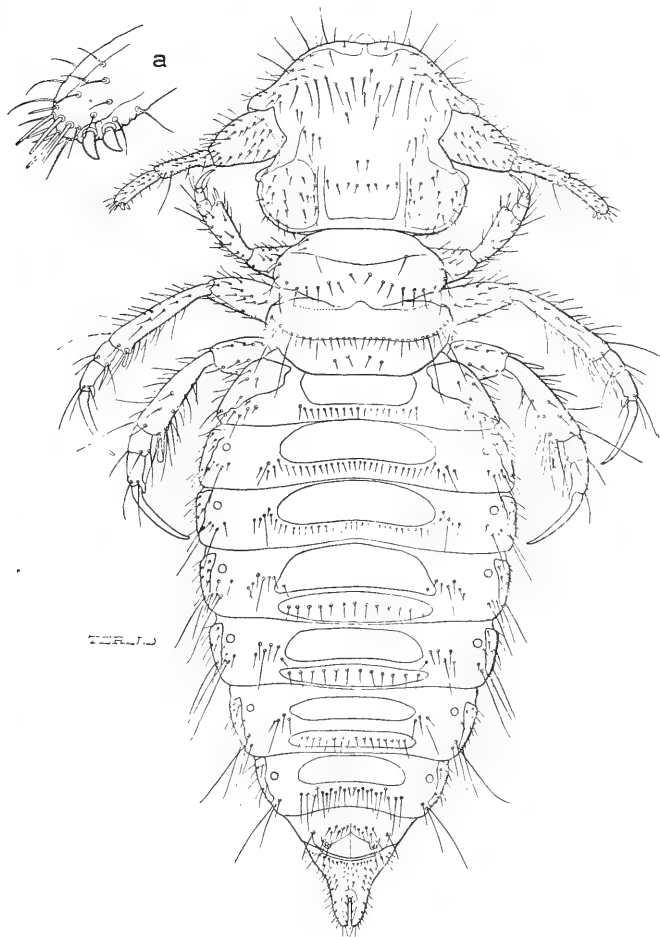
TRICHODECTES HARRISONI, sp. n. (Text-figs. 13-16.)

Several specimens, male and female, collected on the White-tailed Gnu (*Connochates gnu* Zimm.). In the shape of the abdomen of the male, more particularly of the last segment which is produced and has a deep median bay, this new form recalls *Damalinia* and *T. forficula*. There is, however, no frontal sinus, the head being semicircular in front, and I consider its nearest allies, therefore, to be *T. forficula* P. (from *Cervus*

porcinus) and *T. climax* N. (from *Capra hircus*), more especially the former.

The species is named after Mr. Launcelot Harrison, B.Sc., of the University of Sydney.

Text-figure 13.



Trichodectes harrisoni, ♂. \times about 55.

a. Tip of antenna, much enlarged.

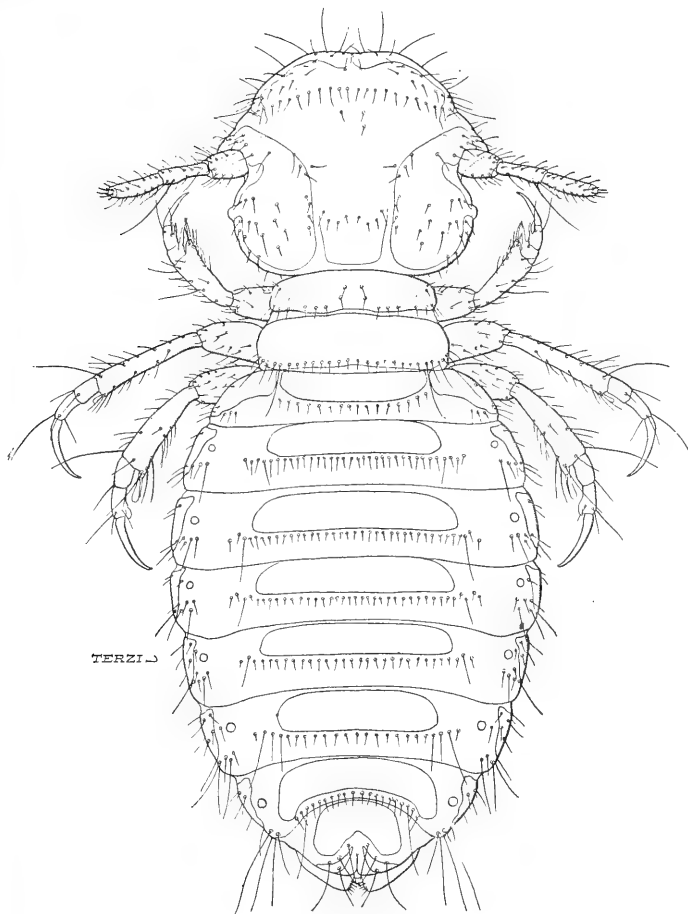
External Form. MALE (text-fig. 13).—*Head*: Front margin semicircular. Marginal band narrow at the sides, broader across the front. Frontal sinus absent. Antennæ arise about midway,

one on each side. Postantennal area as broad as the base of the preantennal semicircle. Temples rounded. Occipital margin broad; the two dorsal rafters of the skull are parallel and widely separated. There are also two ventral rafters pursuing the same course. At the occiput the dorsal and the ventral rafter of each side are united one to the other by a concave broad band forming the sides of the occipital hole. Forwards the dorsal rafters become evanescent in the chitin of the roof, just about the level of the mandibles. Each ventral rafter in front splits into two branches, the outer curling around into the posterior part of the antennary socket and the inner one apparently becoming absorbed in the thick chitin, which gives the mandibles articulation. *Antenna*: First segment large, swollen, all three segments about equal in length. *Hair-canal* absent or, at any rate, very shallow; two somewhat convergent chitinous bands run from the clypeus to the front margin of the head and indicate the sides of the canal. As in *T. climax* and others the frontal marginal band is thickened, with a narrow, median, longitudinal, white cleft. In a greatly developed hair-canal, such as *T. subrostratus* N. possesses, there is no band crossing the frontal sinus, the lateral marginal bands, one on each side, running down the sides of the hair-canal. *Thorax*: Narrower than the head. There are two distinct parts—pro + mesothorax and metathorax or prothorax and meso + metathorax. The latter is a little the broader. Lateral margins of both are rounded. Coxæ of first pair of legs lie close to one another in the centre. First pair of legs short, the tibiæ of the second and third pairs remarkably long. *Abdomen*: Tapers elegantly to the anal extremity. The tip is bifid. The material at my disposal is insufficient to determine the precise morphology of the bifid tip. In *Damalinia*, according to Mjöberg, it is the produced sternite of the last segment. There are two other species of *Trichodectes* with bifid tips to the abdomen, viz., *T. forficula* P. and *T. appendiculatus* P., but I have not been able to examine either of these for comparison. A tergite on each of the first three segments; but each tergite gives a suggestion of being double, and in the following three segments each tergite is plainly divided in half by a transverse light-coloured band. It is possible that these divisions are only colour-differences. On the penultimate segment, a small tergite. The termination of the abdomen is of a clear whitish chitin. A single sternite in each segment. Each sternite, even in the posterior segment, is an integral whole, so that a genital plate may be said to be absent, although the last two sternites are, on each side, bracketed together by a lateral band of brown chitin.

External Form. FEMALE (text-fig. 14).—The usual sexual differences in the antennæ. *Abdomen*: Ovate. A single tergite and sternite on each segment, dark brown in colour. Tergite 1 fits the whole space between the pleurites. In the tergites that follow, there is a clear space laterally between tergite and

pleurite. The gonopods are fairly broad, ear-like plates projecting beyond the end of the abdomen. They cover the sternal surface and lie transversely across the end of the abdomen, their concave surfaces uppermost, adpressed against the sternal abdominal surface.

Text-figure 14.

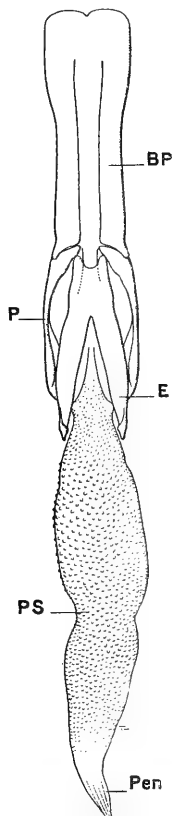


Trichodectes harrisoni, ♀. \times about 56.

Chaetotaxy. MALE.—*Head*: A great many scattered hairs over preantennal area dorsally, and also over dorsal surface of the temples. Median dorsal postantennal area, between the two longitudinal bands, bare except for a transverse row of short hairs. Ventrally, numerous short hairs in preantennal area on each side

of the hair-canals; postantennal area apparently bare. *Thorax*: Small scattered hairs on pronotum and a row along posterior margin. A transverse row of short hairs on metanotum. Other hairs as in the figure. *Abdomen*: A transverse row of quite short, closely-placed hairs along the posterior margin of each tergite; in those segments where two tergites are present, the row runs across the front margin of the second. A small semicircle of short hairs

Text-figure 15.



Trichodectes harrisoni. Male copulatory apparatus. $\times 118.5$.

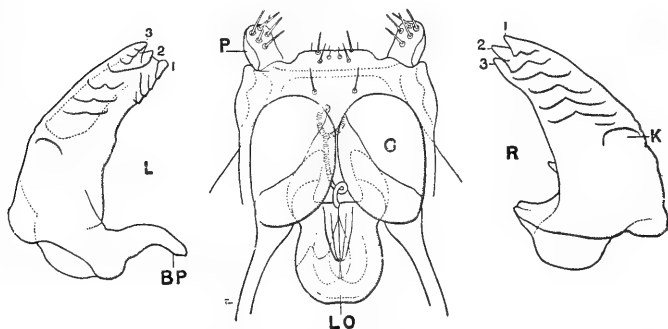
BP. Basal plate; E. endomere; P. paramere; Pen. penis rod; PS. preputial sac.

on anterior lip of genital opening. The whole of the dorsal surface of the apex of the abdomen studded with short hairs. Ventrally, a row of hairs along posterior margin of each sternite. Fewer hairs on ventral surface of the end of the abdomen than on the dorsal. Other hairs as in the figure.

Chaetotaxy. FEMALE.—As in the male, except in the region of the genital opening. Here, a fringe of hairs runs around the margin of each gonopod, and there is a patch of short ones between the gonopods at the base.

Male Copulatory Apparatus.—This resembles that of *T. forficula* according to Piaget's rather obscure figure. *Basal plate:* Consists of two straight parallel-sided marginal bands, parallel to one another, with a transparent and apparently membranous median strip between. At its base for the articulation of the paramere each band is obliquely truncate. *Parameres:* Much shorter than the endomeres. Each paramere in the mid-part of its length is a narrow rod; towards the base its inner margin runs out to form an inner trochanter, as broad as the band of the basal plate to which it is attached. Distally, the paramere broadens dorso-ventrally and forms a concave flange, the concave surface on the

Text-figure 16.



Trichodectes harrisoni. Male mouth-parts (maxillæ not shown). $\times 200$.

L. Left mandible. R. Right mandible. $\times 168$.

G. Gland; K. knob; LO. lyriform organ; P. paraglossa; 1, 2, 3. apices.

inside. *Endomeres:* Large pieces, the tips reaching almost to the genital opening. They are fused into one piece at the base and form a single forked sclerite, concave dorsally, so as to hold the sac. Each limb of the fork is quite broad, but has an acute apex and carries a small nodular tooth subapically. The sac is long, covered with small denticles. *Penis* and *telomeres* are developed on the distal end, but are very delicate and transparent, and hard to make out (text-fig. 15).

Mouth-parts (text-fig. 16).—*Mandibles:* These resemble those of *T. hemitrangi*, than which, however, they are relatively much smaller and less powerful. When in repose, moreover, only the distal ends overlap, that of the right being a little behind and above (on the inside of) the left. In each there are three apices; on the *right* there is the same stout quadrangular process, with

the large knob opposite. On the left there is the usual sharp basal process (present in the left mandible of most Mallophaga). On both mandibles are transverse ridges fewer than in *T. hemitrugi*. *First Maxillæ*: Small lobes that call for no particular remark. *Labium*: "Paraglossæ" short and columnar, rounded at the tips, firm outer surface. Five inwardly directed spines on each distal end. No lobes, labial margin straight. Ten minute hairs, set in large alveoli on the labium, and further back two short hairs, one on each side. *Isopogometric Apparatus*: No posterior cornua on the lyriform organ. Anterior cornua broad, and almost as long as the "nucleus."

Measurements (millimetre scale).

	Length.		Breadth.	
	♂.	♀.	♂.	♀.
Head	·45	·51	·56 (in front of antennæ)	·54
Thorax	·32	·22	·40 (metathorax)	·44 (metathorax)
Abdomen	1·35	1·20	·75 (segment 3)	·88 (segment 3)
Total	2·12	1·93		

Length of Antenna.	♂.	♀.
Segment 1	·150	·076
„ 2	·135	·012
„ 3	·110	·012
Total	·395	·10

Length of Legs, ♂.	1st.	2nd.	3rd.
Femur	·016	·180	·02
Tibia + tarsus	·200	·345	·028
Claw (curved)	·060	·120	?
Total	·276	·645	—

TRICHODECTES OVIS Linn.

Specimens from *Ovis musimon* Linn. Also been recorded from *O. aries*, *O. ornata*, *O. melanocephala*.

TRICHODECTES sp.

12 ♀ ♀ from *Capreolus capreolus* Linn. The specimens belong to the much confused *tibialis*-group of *Trichodectes* from Deer. It is thoroughly unsafe to identify specimens of this series from females until the confusion, caused chiefly by the absence of morphological evidence in previous descriptions and figures, has been dispelled. These females certainly are not *T. tibialis*, but agree most with some unnamed *Trichodectes* from Reed-Buck (Africa), shown me by Mr. Waterston among some material belonging to the Imperial Bureau of Entomology.

Genus EUTRICHOPHILUS Mjöberg.

EUTRICHOPHILUS SETOSUS (Gieb.) (10, p. 56). (Text-fig. 17.)

37 ♀ ♀ from *Erithizon dorsatum* Linn.

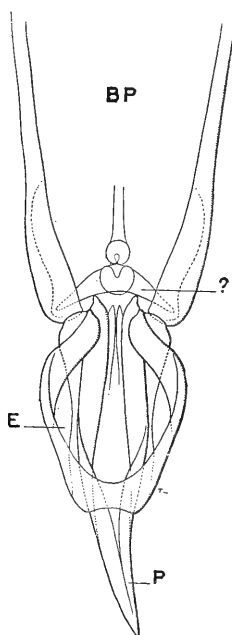
I have been able to make a preparation of the male copulatory apparatus from a male contained in a tube of this species presented to the British Museum by the Hon. N. C. Rothschild. In many species of *Trichodectidæ*, males are rare and in *T. scalaris* N. unknown.

The Family *Trichodectidæ* consists at present of but three genera—*Trichodectes*, *Damalinia*, and *Eutrichophilus*. Before *Damalinia* and *Eutrichophilus* were split off in 1910 by Mjöberg, the old genus *Trichodectes* was simply a miscellany, which still requires breaking up into genera—a by no means easy task, on account of the difficulty in finding convincing characters. In view of a future revision of the family, attention is drawn to the probable value of the male genitalia systematically. I find, for example, that in *Eutrichophilus setosus* and in *E. coëndu* Stobbe (15) the male genitalia are of quite the same type. This is described below. Another type, perfectly distinct, is formed by *Trichodectes latus*, *T. crassus*, *T. pinguis*, and probably by others (see p. 271). Still another type may be seen in the male genitalia of *Trichodectes gastrodes* Cummings (16, p. 99), *T. mephitidis* Osborn (17, p. 242), *T. geomydis* Osborn (18, p. 54), and *T. interrupto-fasciatus* Kell. & Ferris (19, p. 61), which agree in the fusion of the parameres at their distal ends and in the bifid form of the endomeres (see 16, text-fig. 4; and 19, pl. vii. fig. 2, pl. viii. figs. 4 & 6).

Male Copulatory Apparatus (text-fig. 17).—*Basal plate*: Broad anteriorly narrowing gradually to the posterior end, where the plate is constricted into a narrow "waist," to which the endomeres and parameres are attached. The lateral margins are narrow, rod-like, the posterior third broader. The anterior part of the plate, as is frequently the case, is thinned out, composed of delicate chitin with an almost invisible anterior margin.

Parameres: Of the appendages at the base of the plate, I take the outside ones to be endomerai and the two elongate inner ones parameres. The homologies of the other parts figured I do not indicate, pending further dissections.

Text-figure 17.



Eutrichophilus setosus. Male copulatory apparatus. $\times 182$.

BP, Basal plate; E, endomerai chitinisations; P, parameres;
?, problematical parts.

Comparison with the Male Copulatory Apparatus of
E. coëndu Stobbe.

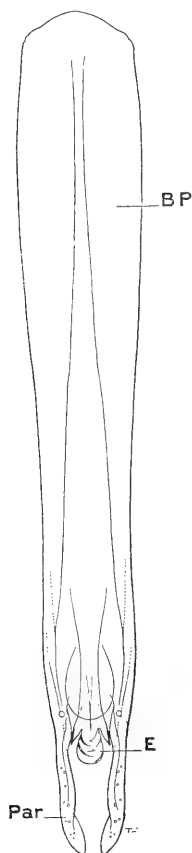
This is of exactly the same type. *Basal plate*; Much broader in relation to its length than that of *E. setosus*, and much broader at the base. Between the two lateral margins at the base lies the same little chitinous piece as in the preceding species, only it is larger and stretches right across the plate, almost from one margin to the other, narrowing at each end; in the middle, pointing upwards and backwards from the hind margin, is a small sharp-pointed process. The two inner appendages are narrow, and twice as long as the outer ones. These, probably the endomerai, are very short, broad, stunted pieces, articulating with the basal plate.

Genus *LÆMOBOTHRIUM* Nitzsch.*LÆMOBOTHRIUM TITAN* Piaget (2, p. 578).

6 ♀ ♀, 3 larvæ from an Accipitrine bird. Host's name not given.

Genus *GONIOCOTES* Burm.*GONIOCOTES MICROTHORAX* Nitzsch (10, p. 184).1 ♂, 1 ♀ from the Common Partridge (*Perdix perdix* Linn.).

Text-figure 18.

*Goniocotes gigas*. Male copulatory apparatus. $\times 87$.

BP. Basal plate; E. endomerai chitinisation; Par. paramere.

The parameres possess sensory hairs in large alveoli. Compare with text-fig. 23.

GONIOCOTES VERRUCOSUS Taschenberg (13, p. 94).

I have ventured to identify with Taschenberg's species a single male from *Crypturus noctivagus* (Wied). The species was described by Taschenberg from a single male taken on *Crypturus variegatus* (Gmel.).

GONIOCOTES sp.

1 larva from *Querquedula flavirostris* (Vieill.).

GONIOCOTES GIGAS Piaget (2, p. 238): (Text-fig. 18.)

1 ♂, 1 ♀, and an immature form from *Crossoptilon mantchuricum* Swinhoe.

The text-figure of the male copulatory apparatus is drawn from a specimen in a tube full of this species, presented to the British Museum by the Hon. N. C. Rothschild.

Male Copulatory Apparatus.—*Basal plate*: Very long and narrow; parallel-sided. Anterior half uniform brown. Posterior half with brown lateral margins and a pale median area. *Parameres*: Relatively short, spear-shaped.

Genus STRONGYLOCOTES Taschenberg.

STRONGYLOCOTES CONICEPS Tasch. (13, p. 63).

1 ♂ from *Crypturus noctivagus* (Wied).

This species is known from a single male specimen taken on *Crypturus variegatus* (Gmel.).

Goniodidæ from Tinamous.

The collection contains Goniodidæ from *Nothoprocta cinerascens* (Burm.), *Rhynchotus rufescens* (Temm.), and *Crypturus noctivagus* (Wied), belonging to four or five different species, but in each instance the material, consisting of but one or two specimens, is insufficient in a confused group such as this to make their determination satisfactory. For the time being, therefore, I am reserving these specimens until the time is ripe for a much-needed revision of Tinamou Goniodidæ.

Genus GONIODES Nitzsch.

GONIODES COLCHICUS Denny (21).

1 ♀ from *Phasianus versicolor* (Vieill.) and 1 imperfect specimen from *P. colchicus*.

GONIODES DISPAR Nitzsch (10, p. 193).

1 ♂, 1 ♀ from the Common Partridge (*Perdix perdix* Linn.).

GONIODES MINOR Piaget (2, p. 256).

1 ♂, 2 ♀ ♀, and 1 larva from *Leptoptila reichenbachii* Pelzeln.

GONIODES MEGACEROS Kell. & Paine (22).

1 ♂ from *Lophophorus refulgens* Temm.

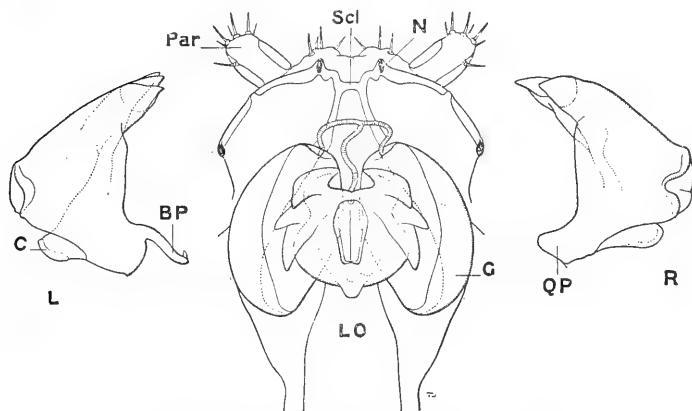
The species is based on a single male from the same host. Concerning the copulatory apparatus, the authors, in passing, note that it is "prominent with heavily chitinated rods reaching to the second abdominal segment." In their figure (pl. xv. fig. 8) the genitalia are shown as seen through the integument, but with the parameres in front and the basal plate behind! The specimen prepared probably had its genitalia exerted and coiled over its back with parameres pointing backwards, and in the course of being mounted the apparatus became pressed down upon the abdomen in the reversed position.

GONIODES FALCICORNIS Nitzsch (10, p. 198). (Text-fig. 19.)

Several specimens from *Pavo cristatus* var. *nigripennis* Slater.

Mouth-parts (text-fig. 19).—*Mandibles*: The left (dorsal surface) is roughly of the shape of an equilateral triangle; at the exterior

Text-figure 19.



Goniodes falcicornis. Mouth-parts. $\times 113.5$.

L. Left mandible. R. Right mandible.

BP. Basal process; C. condyle; G. gland; LO. lyriform organ; N. chitinous nodule; Par. paraglossa; QP. quadrangular process; Scl. sclerite.

basal angle is a small cup-shaped socket where the mandible articulates with the head; at the inner basal angle is the usual tooth-like process which is here in the form of a long narrow stylet, curved at the base, and carrying at the tip preaxially a small recurved tooth. The apex of the triangle is produced, and carries two distinct cutting-edges with separate tips. On the ventral surface the mandible is more of an isosceles triangle in shape, the base-line being shorter and about midway along its length, running out into a large rounded condyle of dense chitin. In the right mandible the basal process as usual is quadrangular, the large

middle condyle is the same as in the right, and the socket at the external angle is somewhat deeper. Two very distinct apices are present, situated laterally one to the other, the longer one separated from the shorter by a considerable space. Ridges in both mandibles absent. *First Maxillæ*: These lobes call for no special mention. *Labium*: "Paraglossæ" as usual; anterior margin is concave in the middle with a small convex swelling on each side carrying four or five spines. On the dorsal surface of the labium, *i. e.* within the oral opening, is visible a sclerite of the same shape and in the same position as that described in *Trichodectes gastrodes* (16, p. 99). It consists of a transverse band with two limbs at each extremity, one anterior and one posterior. The posterior one in this case is very long, and runs back on the inside of the under surface of the labium almost as far as the hind end of the "gland" or basal piece. The anterior one is noteworthy, as it runs forward a short way and then near the base of the paraglossa runs into a dark brown chitinous nodule, visible on the other side of the labium. Shipley (24) regards this nodule described in *G. tetraonis* as a labial appendage. *Œsophageal sclerite*: The text-figure shows the form of this organ in this species.

Male Copulatory Apparatus.—Mjöberg (4, p. 249, text-fig. 142) has published a drawing of this apparatus which is so inaccurate as to require, some time in the future, to be carefully refigured. The morphology of the parts is more or less clear, there being basal plate, parameres, endomeres, and penis, but the features which make this relatively enormous apparatus so remarkable are the strange and complex forms which the several parts have assumed.

GONIODES BICUSPIDATUS Piaget (2, p. 278). (Text-figs. 20–22.)

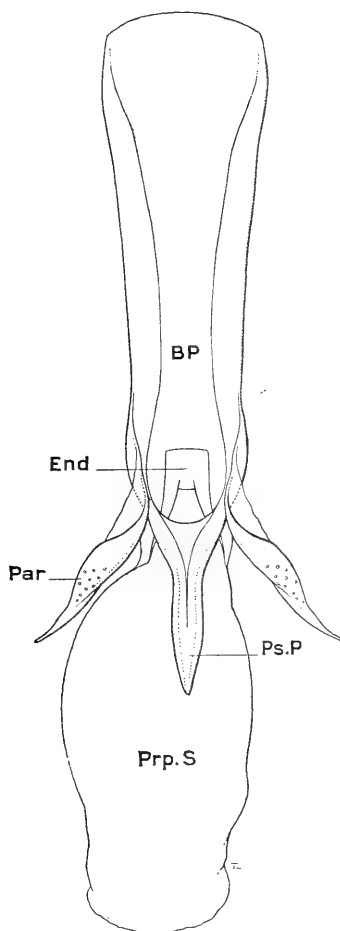
Several specimens from *Tragopan caboti* (Gould).

A tube of the same species from *Cerionis satyrus*, presented to the Museum by Lord Rothschild, contained several larvæ of two stages, the description of which is included below.

Male Copulatory Apparatus (text-fig. 20).—The following description is drawn up from a specimen preserved *in copula* with the female. The parts, therefore, were exerted and their exact relation easily made out. *Basal plate*: Long and fairly broad. Anterior end thin and colourless. Dark brown marginal bands along posterior half. *Parameres*: Rather like a rabbit's ear in outline. The distal end is produced into a very narrow, slender, needle-like apex. The *sac* is covered with small teeth, especially at the distal end, but I have been able to discover no true penis. At the base of the sac the *endomeræ* chitinisations consist of two parts, a dorsal and a ventral. The dorsal is a stout, lanceolate, median piece, quite separate from the sac, and probably functioning as a penis. The ventral is a small, thin, rectangular plate, lying between the two lateral bands at the base of the basal plate, and giving support to the sac. From each

of the two anterior lateral angles it sends off a long supporting process down the membranous sac. When functioning, the parameres stand off at right angles to the sides of the basal plate and serve to anchor the apparatus within the female's genital cavity.

Text-figure 20.



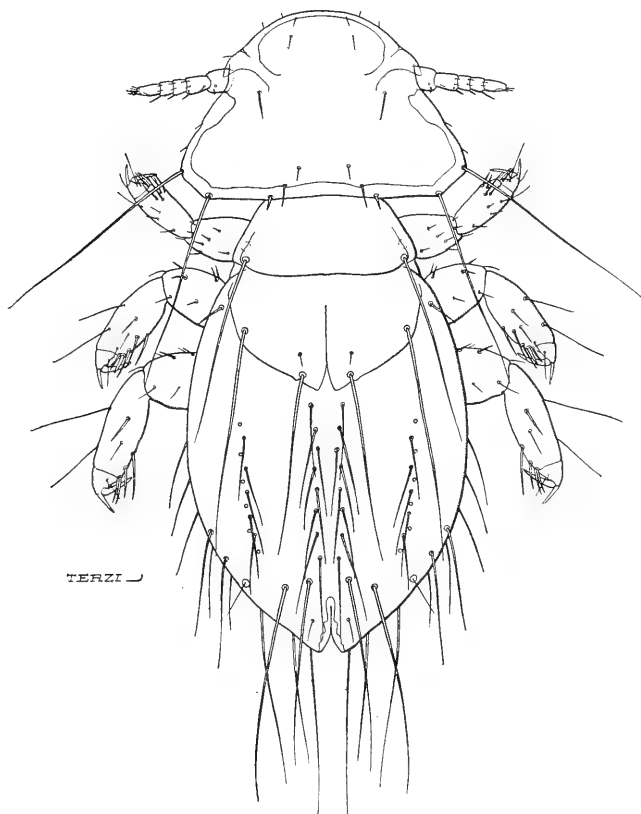
Goniodes bicuspidatus. Male copulatory apparatus. $\times 60$.

BP. Basal plate; End. endomere; Par. paramere; Prp.S. preputial sac;
Ps.P. pseudo-penis.

Larvæ.—The larvæ, I believe, were all those which, ultimately, with one exception (see text-fig. 22, *a*) would have matured into

females, as in all the specimens the head had assumed, even in Stage I., the definitive female form. Both the head and the thorax, not only in form but in chaetotaxy, are practically identical with the adult female, even in the earliest stage in the collection, which will probably prove to be Stage I. I have also made one or two dissections of the larval mouth-parts and can discover no characters in which they differ materially from those of the adults. The larval abdomen, however, requires separate treatment.

Text-figure 21.



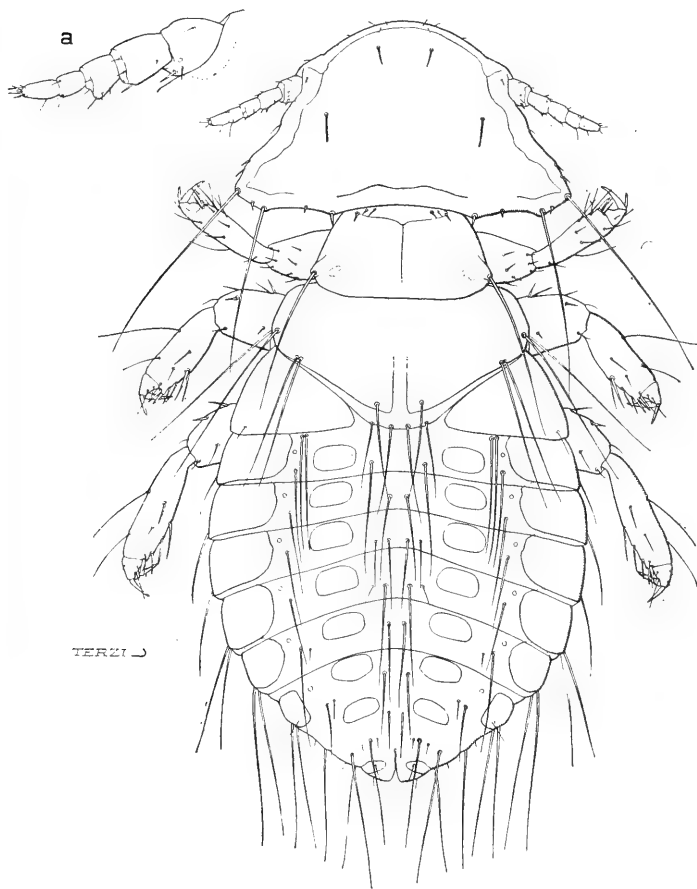
Goniodes bicuspidatus. Larva. Stage I. $\times 49$.

Stage I. (text-fig. 21). *External Form*.—*Abdomen*: Small with an even margin, devoid of all sclerites. *Chaetotaxy*: The arrangement of bristles cannot be safely described from one specimen, and that given in the figure must be regarded as approximate

only. The abdomen bears a great many bristles, all relatively very long and powerful.

Stage II. (text-fig. 22). *External Form.*—*Abdomen*: Pleurites of a simple form developed. As in the adult the pair immediately behind the metanotum are very large and run in over the

Text-figure 22.



Goniodes bicuspidatus. Larva. Stage II. (or III.?). $\times 33$.

a. Antenna of another larva, probably male, showing a slight enlargement of segment 3.

dorsum a considerable way. But the rest are simple quadrilateral plates lying dorsally on the lateral margin. The small

spiracle lies on the inner margin of each pleurite, about halfway along its length. Tergites are present in the form of circular or oval plates, two on each segment, and each tergite is just on the inside of, but separated by a space from, the pleurite. In the adult this space is filled in, and the tergite and pleurite unite.

Chaetotaxy.—*Abdomen*: This differs but little from that of the adult female. But there are apparently some interesting differences from Stage I. (compare the metanotum in text-figs. 21 & 22). There are fewer hairs in the mid-dorsal region of each segment, and the chaetotaxy around the end of the abdomen and the genital opening differs considerably, of course, from the adults, in which the sexual organs are matured.

Genus RHOPALOCERAS Taschenberg.

RHOPALOCERAS STYLIFER Nitzsch (10, p. 200). (Text-figs. 23, 24.)

1 ♂. Host not given; probably from *Meleagris gallopavo* Linn.

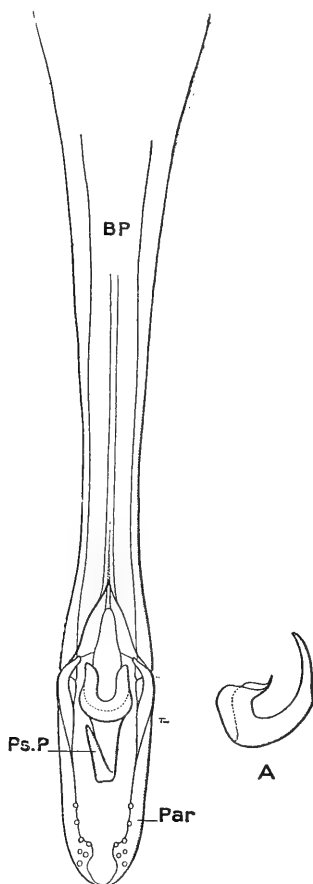
Male Copulatory Apparatus (text-fig. 23).—For the purposes of the following description I have been able to make use of specimens of this common Turkey parasite, kindly placed at my disposal by the Rev. Jas. Waterston, B.Sc.

The apparatus in this remarkable-looking insect presents features of great interest, inasmuch as it is reduced to a very small size (although in no sense atrophied), in correspondence no doubt with the fact that the terminal segments of the abdomen have become modified so as to take part in the function of copulation. Similar adaptation of the end of the abdomen to the function of copulation is not rare in Mallophaga. *Basal plate*: Long and narrow, margins slightly thicker than the median area; the anterior end a little broader and thinner. *Rest of the Apparatus*: This is so highly modified that the attempt here made to bring it into line with the parts in other Mallophaga is only partial and tentative. Parameres as such are absent. Instead, articulating with the basal plate is a small trowel-shaped plate with the concave side uppermost. Along the lateral margins (dorsal surface) of the distal half of this plate there are on each side seven minute directive hairs with large alveoli. Contained within the hollow formed by the trowel-shaped plate, and coiling upwards and backwards so as to resemble a crook, lies the penis (or a pseudo-penis?). This crook-shaped piece at its base is set in a stout horseshoe-shaped piece of dense chitin, the two arms of the horseshoe being directed towards the basal plate. The parts are perhaps a modification of those of *G. gigas* (see text-fig. 18), the parameres having coalesced. (Cf. 4, fig. 143.)

Terminal Segments of the Abdomen of the Male (text-fig. 24). *Dorsal surface*: The 7th tergite is a narrow transverse band which,

unlike the preceding tergites, runs right across the dorsal surface from side to side. This is succeeded by a large shield-like plate of chitin forming the fused tergites of the 8th and 9th segments. There is a deep median bay in its posterior margin, into which

Text-figure 23.



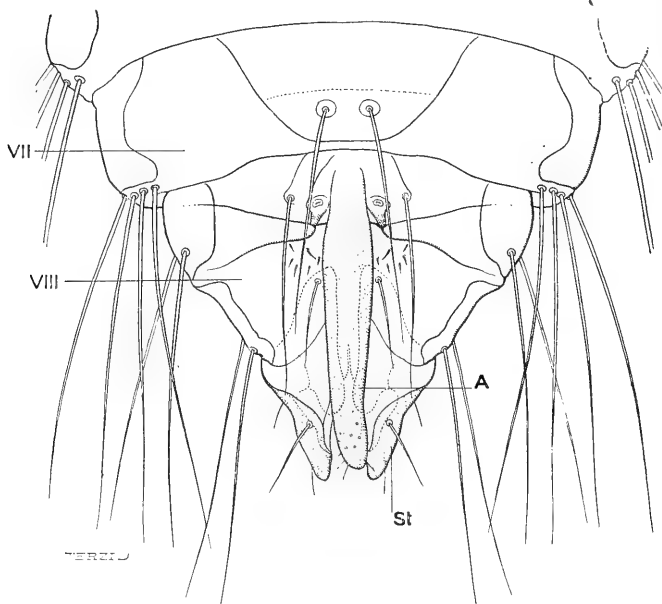
Rhopaloceras stylifer. Male copulatory apparatus. $\times 185$.

BP. Basal plate; Par. paramere (fused); Ps.P. pseudo-penis (A, side view).

is closely fitted the broad bases of the terminal stylets. *Ventral surface*: The 7th sternite is broad and long and, unlike the preceding sternite, runs right across the sternum from side to side. In front, the anterior part encroaches somewhat upon

the sternal area of the 6th segment. Immediately in front of the base of the appendage, which is hinged on to the 8th sternite, the 7th shows a noticeable quadrilateral development of its middle part which carries two bristles. The long, narrow, finger-shaped appendage is attached in the mid-line of the 8th and extends to the end of the abdomen, where it curves up between the two terminal stylets, which are excavated somewhat on their inner surfaces to allow the appendage to pass and to

Text-figure 24.



Goniodes stylifer, ♂. Terminal segments of the abdomen. Ventral view. $\times 58$.

A. Appendage; St. terminal stylet; VII., VIII. segments.

project on the dorsal surface. This appendage on its dorsal surface is concave, convex below. The dorsal channel is formed by the bending over of the free lateral margins, which meet in the middle but can be separated by a needle and bent back and flattened out as a plate. At its base the chitin is pinched up to form a hinge. On each side of the middle line the sternite is developed into a triangular piece, with the apex pointing inwards. The 9th and 10th sternites apparently not developed.

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EXHIBITIONS AND NOTICES.

February 8, 1916.

Prof. E. W. MACBRIDE, D.Sc., F.R.S., Vice-President,
in the Chair.

The SECRETARY read the following report on the Additions to the Society's Menagerie during the months of November, December, and January :—

NOVEMBER.

The number of registered additions to the Society's Menagerie during the month of November was 53. Of these 32 were acquired by presentation, 16 were received on deposit, 3 in exchange, 1 by purchase, and 1 was born in the Gardens.

The number of departures during the same period, by death and removals, was 150.

Amongst the additions special attention may be directed to :—

1 Leopard cub (*Felis pardus*), from Accra, presented by Hugh M. Willoughby on November 12th.

1 Caracal (*Felis caracal*) and 1 Fettered Cat (*F. ocreatus*), from Berbera, presented by Dr. R. E. Drake-Brockman, F.Z.S., on November 30th.

3 Lund's Opossums (*Didelphys albiventris*) and 1 Wied's Opossum (*D. aurita*), from Minas Geraes, both new to the Collection, presented by Prof. J. P. Hill, F.R.S., F.Z.S., on November 6th.

1 Yellow-rumped Tanager (*Rhamphocelus icteronotus*), from Ecuador, new to the Collection, presented by Alfred Ezra, F.Z.S., on November 13th.

DECEMBER.

The number of registered additions to the Society's Menagerie during the month of December was 107. Of these 68 were acquired by presentation, 37 were received on deposit, and 2 in exchange.

The number of departures during the same period, by death and removals, was 144.

Amongst the additions special attention may be directed to :—

1 Eyra Cat (*Felis eyra*), 1 Salt-Desert Cat (*F. salinarum*), and 1 Allamand's Grison (*Grison allamandi*), the last two new to the Collection, from Cordova in the Argentine, presented by W. A. Smithers, C.M.Z.S., on December 16th.

2 Mongolian Sousliks (*Citellus mongolicus*) and 2 Sand-Hamsters (*Cricetulus griseus*), the latter new to the Collection, and

3 Great Eagle Owls (*Bubo bubo*), from Mongolia, presented by A. L. Hall on December 10th.

JANUARY.

The number of registered additions to the Society's Menagerie during the month of January was 57. Of these 43 were acquired by presentation, 8 were received on deposit, 3 in exchange, and 3 were born in the Gardens.

The number of departures during the same period, by death and removals, was 123.

Amongst the additions special attention may be directed to:—

1 Anoa (*Anoa depressicornis*) ♀ from Celebes, and 1 Père David's Deer (*Elaphurus davidianus*) ♂ from Northern China, presented by H.G. The Duke of Bedford, K.G., Pres.Z.S., on January 20th and 26th.

2 Argentine Frogs (*Leptodactylus mystacinus*) and 6 South-American Sand-Toads (*Bufo arenarum*) from Cordova, Argentina, new to the Collection, presented by Wilfred A. Smithers, C.M.Z.S., on January 31st.

Mr. R. E. HOLDING exhibited the skull of a Roebuck, showing an unusual deviation in the direction of the suture of the right frontal bone, which extended considerably beyond the median line towards the left.

Mr. C. TATE REGAN, M.A., F.Z.S., exhibited, by means of lantern-slides, a series of drawings of larval Fishes from the Antarctic.

The development of *Myctophum antarcticum* was compared with that of the northern *M. glaciale*, and larval Nototheniidæ were described.

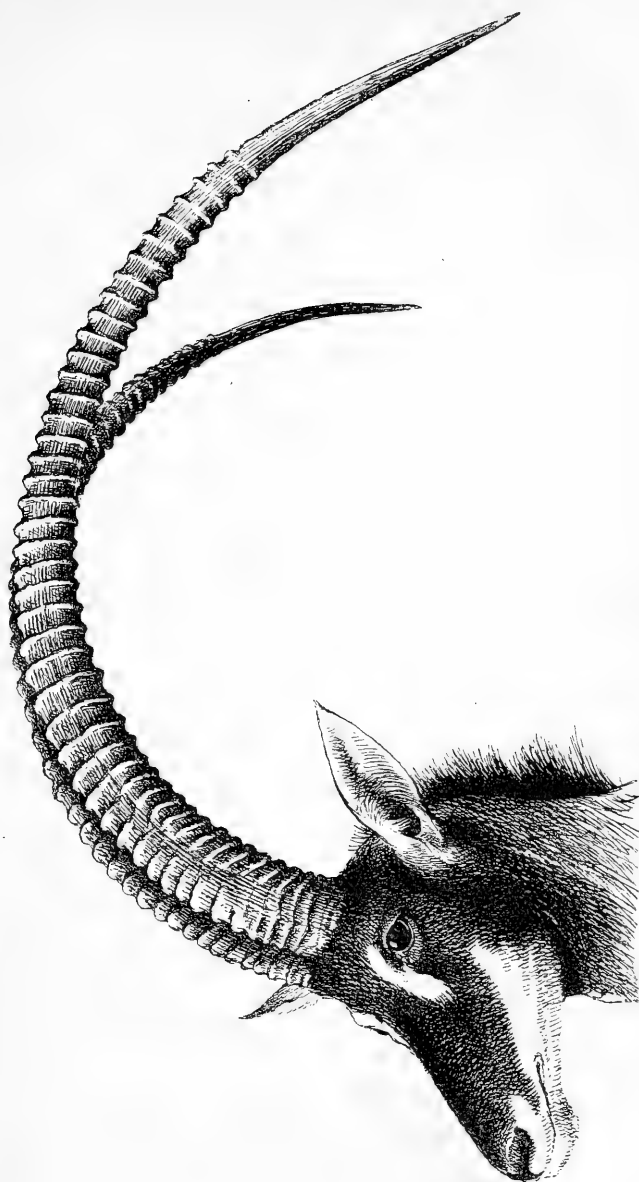
A new Sable Antelope from Angola *.

Mr. OLDFIELD THOMAS, F.R.S., F.Z.S., exhibited the scalp and frontlet, with horns, of a male Sable Antelope from the Luando River, Angola, which had been presented to the National Museum, together with a female mask and horns, by Mr. H. F. Varian.

This magnificent animal differed widely from the ordinary Sable, both by its immensely finer horns, and by the characters

* [The complete account of the new subspecies described in this communication appears here; but since the name and a preliminary diagnosis were published in the 'Abstract,' No. 151, 1916, it is distinguished by the name being underlined.—EDITOR.]

Text-figure 1.



Head of Angolan Sable Antelope (*Hippotragus niger varians*).

of its face-marking, and Mr. Thomas proposed to distinguish it as a new subspecies under the name of

HIPPOTRAGUS * NIGER VARIANI †.

Thomas, Abstract P. Z. S. 1916, p. 1 (Feb. 15th).

The horns of the type measured 57 inches (1445 mm.) in length along the front curve, by 11 inches (280 mm.) in circumference at the base, and 27 inches from tip to tip. Their transverse ridges, which were extremely well marked, were 47 in number. Good Rhodesian and Nyasa Sable horns were about 45 to 50 inches in length, while those of the East African Sable were not known to reach 40 inches. The female horns of *H. n. variani* were 35 inches (890 mm.) in length by 7 inches (179 mm.) in circumference.

A skull of this form, which had been lent to Mr. Thomas for comparison, measured 480 mm. in length, 170 mm. in breadth, with an upper tooth-row of 122 mm., these dimensions in a skull of the ordinary Sable being respectively 435, 160, and 114 mm.

But, apart from its splendid horns, the most striking character of *H. n. variani* was the practically complete obliteration of the usual prominent white streaks running from the anteorbital white tufts forwards to the sides of the muzzle, the whole of the upper side of the face being therefore deep black, with the exception of the anteorbital tufts themselves, which were white as usual. Along the ordinary positions of the white streaks a few lighter hairs were perceptible, these being rather more numerous in the female.

The dark parts of the head were of the deepest black, the light parts buffy whitish or cream-colour, except the middle line of the interramia, which was white. Occiput mixed black and ferruginous-tawny. Ears, as usual, rich tawny outside, and white within. The face of the female was blackish brown, and the crown and occiput tawny.

It was with considerable hesitation that Mr. Thomas had only distinguished this Sable as a subspecies, and not as a species, so striking was the difference from ordinary Sables in both horns and marking; but the presence of light hairs along the usual position of the facial streaks, and the fact that in *H. n. kirkii* (figured by Matschie as *H. n. kauffmanni*), the nearest neighbour of *H. n. variani*, the dark stripes were broader and the light stripes narrower than in *H. n. niger*, showed that these markings were variable and plastic, and did not indicate any really

* This generic name was used provisionally pending the decision of the authorities as to the names suggested in 1914 for fixation by Fiat. Should *Hippotragus* be rejected, the technical name of the genus would be still in doubt until the question of the validity of *Egocerus*, Desm. 1822, *nec Aegoceros*, Pall. 1811, was settled, a very knotty point. A law covering this latter case had been proposed by the Linnean Society's Committee on Nomenclature in 1906, and submitted to the International Congress, who, however, only accepted it as applying to specific names, a restriction much to be regretted.

† Type. Face, skin, and frontlet with horns. B.M. 16.2.21.1.

essential difference, such as to render unlikely the possibility that intermediates might yet be found.

To this subspecies there presumably belonged the well-known 61-inch horn in the Florence Museum, which had long been a wonder to all sportsmen, who had only had for comparison with it the relatively short horns of *H. n. niger*, those of the E. African *H. n. roosevelti* being still shorter.

Bocage's *Hippotragus niger*, in his papers on Angolan Mammals, was of course also *H. n. variani*, but his only material was a single pair of horns, 51 inches in length, brought home from the "interior of Mossamedes" by Welwitsch.

Mr. Varian had taken great pains to secure specimens of this animal, and to obtain information about its range, and it was with much pleasure that Mr. Thomas had named it in his honour. Mr. Varian had also taken steps to induce the local authorities to give it protection, which, in view of the considerable sums given for such horns as it carried, would be much needed to save it from extermination, now that its existence had become known to sportsmen and hunters.

Judging by the greater length of the skull, it would, no doubt, prove that *H. n. variani* not only carried longer horns, but was larger in all dimensions than the true Sable. It was hoped that a complete specimen of this splendid addition to the list of African Antelopes would soon be obtained for the National Museum, whose warmest thanks were already due to Mr. Varian for the donation of the fine trophy now exhibited.

Antlers of a Virginian Deer affected by Cancer.

Mr. R. I. Pocock, F.R.S., F.Z.S., Curator of Mammals, exhibited the successive Antlers of a Virginian Deer (*Odocoileus americanus*) that had died of cancer in the Society's Gardens, and made the following remarks:—

"The male Virginian Deer (*Odocoileus americanus*) referred to in Prof. Plimmer's report (see p. 83, 16) as having died of cancer, was purchased as a young animal on Jan. 17th, 1911, and died Dec. 27th, 1915. The following accurate records of its successive antlers were kept during the five years that it lived in the Gardens:—

1. The first antlers, shed March 15th, 1912, were simple snags about $\frac{1}{2}$ inch in length.
2. The second antlers, shed March 23rd, 1913, measured $10\frac{1}{4}$ inches along outer curve, were simply forked at the tip; the supernumerary tine on the back of the beam measured just under $1\frac{3}{4}$ inch, and the two antlers together weighed $5\frac{1}{4}$ oz.
3. The third antlers, shed March 24th, 1914, measured 9 inches, were simple, carrying no supplementary tine. The two together weighed $4\frac{1}{4}$ oz.

4. The fourth antlers, shed March 15th, 1915, measured $7\frac{3}{4}$ inches; the left antler was simple, the right was forked, the supplementary tine measuring $1\frac{1}{4}$ inches. The two antlers together weighed $3\frac{3}{4}$ oz.
5. The fifth antlers, unburnished, were taken off the head of the dead animal on Dec. 27th, 1915. The longer of the two measured $8\frac{1}{8}$ inches. The right was simple, the left forked, the supplementary tine measuring $\frac{3}{4}$ inch. The two together weighed $3\frac{3}{4}$ oz.

Thus, although there was a great and, so far as I am aware, normal increase in size of the second antlers as compared with the first, the third, fourth, and fifth antlers showed no corresponding elaboration, but, on the contrary, degeneration, the third being shorter and lighter than the second, and producing no tines. The fourth also were lighter and shorter than the third. Nevertheless, the right one produced a supplementary tine which, however, was shorter than the supplementary tines of the second pair. The fifth antlers in the matter of length showed a slight recovery as compared with the fourth, and the two together acquired the same weight, but the supplementary tine was still shorter, and the dried integument adhered to the antlers instead of peeling off and leaving them normally burnished. Since, in Prof. Plimmer's opinion, the growth of the cancer from which this Stag died was probably a gradual process extending over a few years, it seems justifiable to infer, in the absence of any other obvious cause to account for the fact, that degeneration of the antlers was attributable to this disease. It may be added that the testicles, which Prof. Plimmer particularly examined at my request, were unaffected by the cancer, and were normal except for the absence of ripe spermatozoa."

February 22, 1916.

Dr. A. SMITH WOODWARD, F.R.S., Vice-President,
in the Chair.

The Rev. H. N. HUTCHINSON, M.A., F.Z.S., exhibited a number of drawings prepared by Mr. T. W. Parfitt of restorations of various extinct animals.

Mr. C. TATE REGAN, M.A., F.Z.S., gave a lantern-exhibition illustrating the breeding-habits of a Siamese Fighting-Fish (*Betta splendens* Regan) and the climbing-habits of a Cat-fish (*Arges marmoratus* Regan) from the Andes of Colombia.

The Tympanic Bulla in Hyænas.

Mr. R. I. POCOCK, F.R.S., F.Z.S., Curator of Mammals, gave an exhibition, illustrated by lantern-slides, to show the presence of two chambers in the tympanic bulla of the Hyænidæ, and remarked:—

“In his paper upon the base of the skull in the Fissipede Carnivora (P. Z. S. 1869, pp. 4–37), Prof. Flower laid stress upon the presence or absence of a bony partition dividing the cavity of the tympanic bulla into two compartments in the Æluroidea. Although on general grounds he followed Turner* in classifying the Hyænas with the Felidæ and Viverridæ, he described the bulla of the Hyænas as ‘perfectly simple within, without trace of division into compartments’ (p. 26). Subsequently, Mivart (P. Z. S. 1882, p. 199) wrote ‘though there is no septum, yet I have detected in both species of *Hyæna*, inside the auditory bulla, two osseous ridges or laminæ, which, if further developed, would divide off a small anterior chamber from the much larger and externally more prominent posterior portion.’ These two papers appear to be the sources whence subsequent authors, like Weber, Sedgwick, and others, have derived their information; Weber, following Mivart, described the partition as low, and Sedgwick, following Flower, recorded it as absent.

Both Flower and Mivart were quite mistaken; the bulla in all Hyænas is divided by a strong partition into a larger outer or anterior and a smaller inner or posterior chamber.

It may be recalled that in the Felidæ and Viverridæ the septum rises from the floor of the bulla and typically extends upwards till it touches the periotic (petrous) bone. This partition may arise just below the lower rim of the external auditory meatus, or it may arise far away from that point. In the former case the antero-external chamber is small, in the latter it is large as compared with the postero-internal or posterior chamber; but the free edge of the partition always reaches, or is situated close to, the same portion of the periotic, namely, the portion which is pierced by the *fenestra rotunda* of the inner ear, and it is always just at this point that there is a passage or orifice between the two chambers.

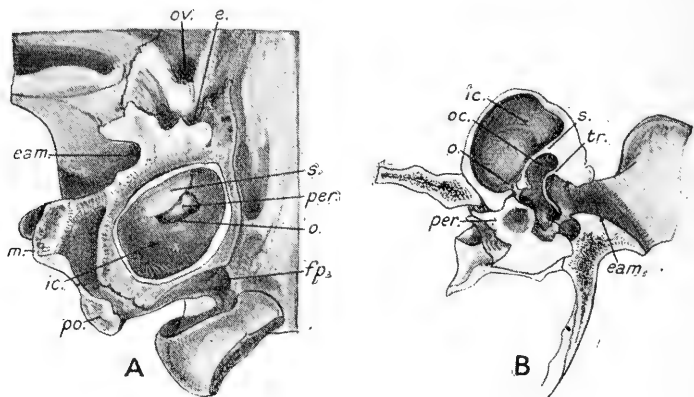
The outer chamber is itself partially divided from the external auditory meatus by a horseshoe-shaped ridge or crest, the tympanic ring, which is well shown in Flower’s figure of the section of the bulla of the Tiger (text-fig. 1, B, *tr.*).

When the bulla of the inverted skull of the Hyæna is opened

* P. Z. S. 1848, pp. 63–88. Flower’s paper is little more than an amplification of this valuable paper by Turner, so far as the Carnivora are concerned. It does not seem, however, that Turner was acquainted with this partition, his mention of the division of the bulla into two parts referring to the superficial groove marking the position of the partition.

anywhere between its anterior extremity and the paroccipital process, it presents the appearances which misled Flower and

Text-figure 1.



(Copied from Flower's figures, P. Z. S. 1869, pp. 16-17.)

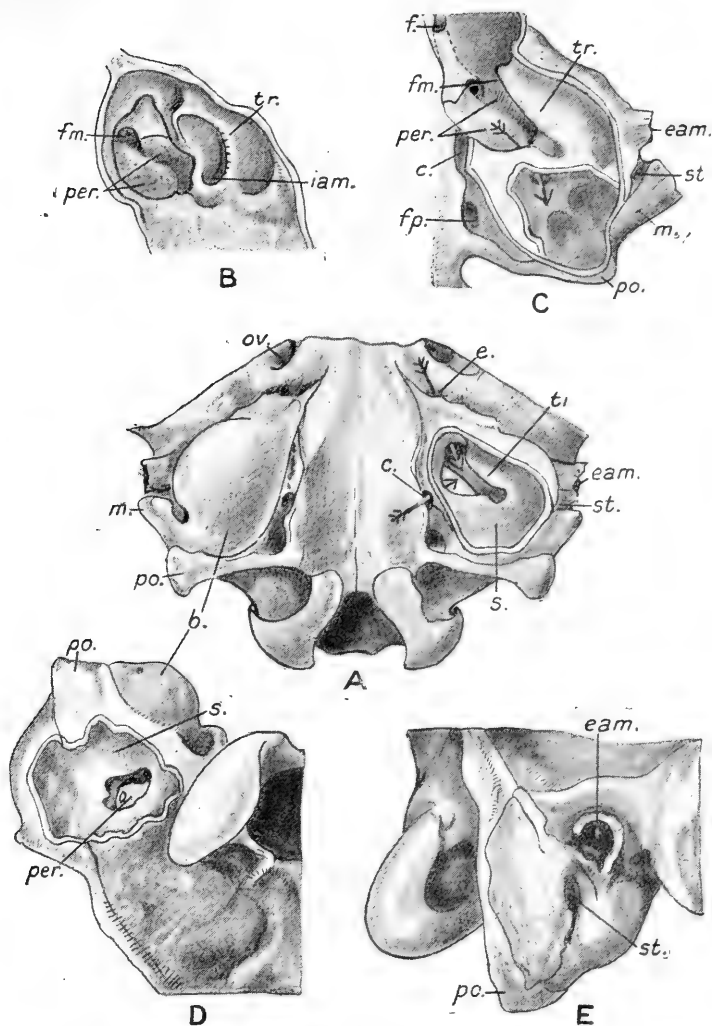
- A. Right half of the base of the skull of the Tiger (*Felis tigris*) with the bulla laid open to expose the inner chamber (*ic.*), with the septum or partition (*s.*) ascending to the periotic (*per.*), and the orifice (*o.*) leading from the inner to the outer chamber between the septum and the periotic; *e.*, internal orifice of eustachian tube; *ov.*, foramen ovale; *fpa*, foramen lacerum posticum; *po.*, paroccipital process; *m.*, mastoid; *eam.*, external auditory meatus.
- B. Section of the auditory bulla of the Tiger. *ic.*, inner chamber; *oc.*, outer chamber with the orifice (*o.*) between the two and the septum (*s.*) dividing them; *tr.*, half the tympanic ring in the outer chamber; *eam.*, external auditory meatus; *per.*, periotic.

Mivart. The greater part of the space is occupied by a single large cavity, which opens by a wide cleft in front into a smaller

Description of Text-figure 2 (*continued*).

- C. Left bulla enlarged, with the posterior portion of the septum, marked *s* in fig. A, cut away to show the cavity of the inner chamber and the antero-internal portion of the bulla also cut away, and the carotid canal (*c.*) laid open; the passage leading from the outer to the inner chamber between the periotic (*per.*) and the septum marked by an arrow. *f.*, foramen piercing sphenoid and corresponding with the anterior carotid foramen of Mongooses; *fpa*, foramen lacerum posticum. Other lettering as in figs. A & B.
- D. Part of the right side of the skull viewed from the occipital aspect, with the bulla laid open from behind to show the inner chamber with the periotic (*per.*), carrying the fenestra rotunda, partially blocking the orifice between the two chambers divided by the septum (*s.*). Other lettering as in fig. A.
- E. Right bulla of the Spotted Hyena (*Crocuta crocuta*). A line drawn between the paroccipital process (*po.*) and the stylomastoid foramen (*st.*) would mark the edge of the partition between the two chambers.

Text-figure 2.



A. Base of the skull of the Striped Hyæna (*Hyæna hyæna*) with the left tympanic bulla opened. *b.*, right tympanic bulla; *c.*, carotid canal, its course shown by an arrow; *e.*, inner orifice of eustachian tube, the course of which is shown by an arrow; *eam.*, external auditory meatus; *s.*, partition or septum between the two chambers; *tr.*, tympanic ring; *st.*, stylomastoid foramen; *po.*, paroccipital process; *m.*, mastoid; *ov.*, foramen ovale.

B. Anterior portion of left bulla enlarged and viewed obliquely from the inner side to show that the crest mistaken by Mivart for a low septum is the tympanic ring (*tr.*), with the internal auditory meatus (*iam.*); *per.*, periotic; *fm.*, foramen lacerum medium, exaggerated in size.

cavity continuous with the eustachian tube and the external auditory meatus. This cleft deeply notches the floor of the large cavity, and the floor slopes backwards and upwards from the cleft, through which a portion of the periotic is visible, to the paroccipital process. The edges of the cleft are no doubt the 'two osseous ridges or laminae which, if further developed, would divide off a small anterior chamber from the much larger . . . posterior portion,' described by Mivart. That is true; but the two chambers would not correspond to the two present in the Tiger, for the outer of the two laminae is the tympanic ring, and is therefore not the homologue of the partition dividing the Tiger's bulla, as Mivart supposed. The 'small anterior chamber' of the bulla, which is exceptionally large in the Hyænas, is merely the anterior part of the tympanic chamber.

Whether Flower correctly interpreted this lamina as the tympanic ring or not, does not appear; but he may be given the benefit of the doubt. Nevertheless, both he and Mivart failed to detect that where the apparent floor—or roof, if the skull be held in its normal position—of the bulla abuts against the periotic, there is quite a distinct orifice through which a probe can be passed backwards into a second chamber lying behind and below the apparent floor of the bulla. This chamber can be laid open by cutting away the paroccipital bone externally to the occipital condyle. It will then be seen quite clearly that the bony plate, regarded by Flower and Mivart as the floor (or roof) of the bulla, is, in reality, a partition dividing the bulla into two chambers, and passing from the periphery of the cavity of the bulla to the periotic, exactly as is the case in the Tiger, allowance being made for the origin of the partition much farther back than in that Feline. It is not, however, much farther back than in some other Æluroids, e. g., *Cynictis*.

Nevertheless, it is not certain, in my opinion, that the partition in the Hyænas is the exact homologue of that of the Cats. The inner wall of the posterior chamber of the bulla in Æluroidea is often strengthened by bony crests or ridges of varying height, and one such crest, curving round the back of the chamber and occupying the position of the partition, where it rises from the bulla near the paroccipital, in *Hyæna*, is present in two immature skulls of *Proteles*, in addition to the normal vertical partition which in these specimens is thin and imperfectly ossified or fenestrated. The interest of this fact lies in the circumstance that *Proteles* in several of its cranial characters occupies a position midway between *Hyæna* and the Mungotinae. Hence it is possible that in *Hyæna* the normal partition has been replaced by a secondary partition of stronger growth. However that may be, it is quite clear that the bulla of *Hyæna* can no longer be described as undivided.

Two other points of systematic importance may be alluded to: the bulla in Hyænas is fused anteriorly to the basisphenoid, as

in the Cats, and beneath its anterior end, and concealed by it, there is a foramen piercing the sphenoid and remote from the foramen lacerum medium. This sphenoidal foramen seems to correspond exactly with the exposed foramen by which the internal carotid artery in the Mongooses enters the skull, after traversing the bulla. In the Hyænas, nevertheless, this artery is said by Mivart to enter the skull by the foramen lacerum medium, the existence of a carotid foramen in the sphenoid being denied by that author. The foramen, nevertheless, persists, as it does in *Proteles*, whether the carotid enters it or not."

March 7, 1916.

The MARQUESS OF SLIGO, Vice-President,
in the Chair.

Mr. HARRY K. EUSTACE gave a bioscope exhibition of films illustrating his experiences as a big-game hunter and cinematographer in East Africa, showing the natives and the characteristic animals of that country in their natural state.

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

February 8th, 1916.

Prof. E. W. MACBRIDE, D.Sc., F.R.S., Vice-President,
in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

The SECRETARY read a Report on the Additions to the Society's Menagerie during the months of November and December, 1915, and January 1916.

Mr. R. E. HOLDING exhibited the skull of a Roebuck, showing an unusual deviation in the direction of the suture of the right frontal bone, which extended considerably beyond the median line towards the left.

Mr. OLDFIELD THOMAS, F.R.S., F.Z.S., exhibited the scalp and frontlet with horns of a male Sable Antelope from the Luando River, Angola, which had been presented to the National Museum by Mr. H. F. Varian, together with a female mask and horns.

This magnificent animal differed widely from the ordinary Sable both by its far finer horns and by the character of its face-markings, and Mr. Thomas proposed to distinguish it as a new subspecies under the name of *Hippotragus niger variani*.

The horns of the type measured 57 inches in length along the front curve, by 11 inches in circumference at the base, and had

* This Abstract is published by the Society at its offices, Zoological Gardens, Regent's Park, N.W., on the Tuesday following the date of Meeting to which it refers. It will be issued, along with the 'Proceedings,' free of extra charge, to all Fellows who subscribe to the Publications; but it may be obtained on the day of publication at the price of *Sixpence*, or, if desired, sent post-free for the sum of *Six Shillings* per annum, payable in advance.

47 transverse ridges upon them. Good South African and Nyasa Sable horns were ordinarily about 45 to 50 inches in length, while those of the East African Sable were not known to reach 40 inches. The female horns of *H. n. variansi* were 35 inches long.

In colour the face of the new form differed conspicuously by the almost complete obliteration of the usual prominent white streaks running from the anteorbital white tufts forwards to the sides of the muzzle, the whole of the upper side of the face being therefore deep black, with the exception of the anteorbital tufts themselves, which were white as usual. In both male and female a few odd light hairs alone indicated the ordinary position of the streaks.

The type-specimen would be registered as B.M. No. 16.2.21.1.

Mr. C. TATE REGAN, M.A., F.Z.S., exhibited, by means of lantern-slides, a series of drawings of larval Fishes from the Antarctic.

The development of *Myctophum antarcticum* was compared with that of the northern *M. glaciale* and larval Nototheriidæ were described.

Mr. R. I. POCKOCK, F.R.S., F.Z.S., Curator of Mammals, exhibited the successive Antlers of a Virginian Deer (*Odocoileus americanus*) that had died of cancer in the Society's Gardens, and attributed the degeneration shown to this disease.

Prof. H. G. PLIMMER, F.R.S., F.Z.S., Pathologist to the Society, read his Report on the Deaths which occurred in the Society's Gardens during 1915, and on the Blood-parasites found during the same period.

Prof. E. B. POULTON, M.A., F.R.S., F.Z.S., presented a paper on a collection of Moths made in Somaliland by Mr. W. Feather, containing descriptions of ten new genera and a large number of new species by Sir George F. Hampson, Bt., F.Z.S., and others.

The next Meeting of the Society for Scientific Business will be held on Tuesday, February 22nd, 1916, at half-past FIVE o'clock P.M., when the following communications will be made:—

The Rev. H. N. HUTCHINSON, B.A., F.Z.S.

Exhibition of drawings of Extinct Animals.

R. I. Pocock, F.R.S., F.Z.S.

Exhibition to illustrate the structure of the Tympanic Bulla in Hyænas.

C. TATE REGAN, M.A., F.Z.S.

Lantern exhibition of the nest of a Fighting Fish and the climbing habits of a Catfish.

BRUCE F. CUMMINGS.

Studies on the Anoplura and Mallophaga, being a Report upon a Collection from the Society's Gardens.—Part I.

P. CHALMERS MITCHELL, M.A., D.Sc., F.R.S., F.Z.S.

Further Observations on the Intestinal Tract of Mammals.

The following Papers have been received :—

G. A. BOULENGER, F.R.S., F.Z.S.

1. On the Lizards allied to *Lacerta muralis*, with an Account of *Lacerta agilis* and *L. parva*.

2. On Specimens of the Bolti, *Tilapia nilotica*, a Teleostean Fish with increased number of Anal Spines.

Major R. MEINERTZHAGEN, F.Z.S.

Notes on the Sitatunga or Marsh-Antelope of the Sesse Islands.

T. GOODEY, D.Sc.

Observations on the Cytology of Flagellates and Amœbæ obtained from old stored Soil.

ROBERT GURNEY, M.A., F.Z.S.

On some fresh-water Entomostraca from Ceylon.

The Publication Committee desire to call the attention of those who propose to offer Papers to the Society, to the great increase in the cost of paper and printing. This will render it necessary for the present that papers should be condensed, and be limited so far as possible to the description of new results.

Communications intended for the Scientific Meetings should
be addressed to

P. CHALMERS MITCHELL,

Secretary.

ZOOLOGICAL SOCIETY OF LONDON,
REGENT'S PARK, LONDON, N.W.
February 15th, 1916.

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

February 22nd, 1916.

Dr. A. SMITH WOODWARD, F.R.S., Vice-President,
in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

The Rev. H. N. HUTCHINSON, B.A., F.Z.S., exhibited a number of drawings prepared by Mr. T. W. Parfitt of restorations of various extinct animals.

Mr. C. TATE REGAN, M.A., F.Z.S., gave a lantern-exhibition illustrating the breeding-habits of a Siamese Fighting-Fish (*Betta splendens* Regan) and the climbing-habits of a Cat-fish (*Arges marmoratus* Regan) from the Andes of Colombia.

Mr. R. I. Pocock, F.R.S., F.Z.S., Curator of Mammals, gave an exhibition, illustrated by lantern-slides, to show the structure of the tympanic bulla in the Hyænas, and pointed out that both Flower and Mivart were wrong in stating that the Hyænas differ from the Felidæ, Viverridæ, and Protelidæ, in having the cavity of the bulla undivided by a bony septum. The septum, which those authors mistook for the roof of the bulla, runs from the back of the bulla, where it abuts against the paroccipital, obliquely upwards and forwards to the periotic, and divides the cavity of the bulla into an anterior larger and a posterior smaller chamber. The Hyænas thus agree with the other families of Æluroid Carnivores in having the bulla divided.

* This Abstract is published by the Society at its offices, Zoological Gardens, Regent's Park, N.W., on the Tuesday following the date of Meeting to which it refers. It will be issued, along with the 'Proceedings,' free of extra charge, to all Fellows who subscribe to the Publications; but it may be obtained on the day of publication at the price of *Shapence*, or, if desired, sent post-free for the sum of *Six Shillings* per annum, payable in advance.

Mr. BRUCE F. CUMMINGS read a paper containing the first part of a report on a collection of Anoplura and Mallophaga obtained from animals in the Society's Gardens. He dealt with the structure and development of the various species, and gave descriptions of three new forms.

Dr. P. CHALMERS MITCHELL, M.A., F.R.S., F.Z.S., Secretary to the Society, gave an account of his paper entitled "Further Observations on the Intestinal Tract of Mammals," illustrating his remarks with a large series of lantern-slides.

The next Meeting of the Society for Scientific Business will be held on Tuesday, March 7th, 1916, at half-past FIVE o'clock P.M., when the following communication will be made :—

CINEMATOGRAPH EXHIBITION.

The SECRETARY has been able to arrange with Mr. HARRY K. EUSTACE, Big Game Hunter and Cinematographer, to give an exhibition of his films of African Animals at this Meeting.

The Papers previously announced for reading at this Meeting are postponed.

The following Papers have been received :—

R. I. Pocock, F.R.S., F.L.S., F.Z.S.

Lantern-exhibition to show structure of the Alisphenoid Canal in some Civets and Hyænas.

Major R. MEINERTZHAGEN, F.Z.S.

Notes on the Sitatunga or Marsh-Antelope of the Sesse Islands.

G. A. BOULENGER, F.R.S., F.Z.S.

1. On Specimens of the Perciform Fish, *Tilapia nilotica*, with Increased Number of Anal Spines.

2. On the Lizards allied to *Lacerta muralis*, with an Account of *Lacerta agilis* and *L. parva*.

T. GOODEY, D.Sc.

Observations on the Cytology of Flagellates and Amœbæ obtained from old stored Soil.

ROBERT GURNEY, M.A., F.Z.S.

On some Fresh-water Entomostraca from Ceylon.

R. I. POCKOCK, F.R.S., F.L.S., F.Z.S.

On the External Characters of the Mongooses (Mungotidæ).

The Publication Committee desire to call the attention of those who propose to offer Papers to the Society, to the great increase in the cost of paper and printing. This will render it necessary for the present that papers should be condensed, and be limited so far as possible to the description of new results.

Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,

Secretary.

ZOOLOGICAL SOCIETY OF LONDON,

REGENT'S PARK, LONDON, N.W.

February 29th, 1916.

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

March 7th, 1916.

The MARQUESS OF SLIGO, Vice-President,
in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

Mr. HARRY K. EUSTACE gave a bioscope exhibition of his films illustrating his experiences as a big-game hunter and cinematographer in East Africa, showing the natives and the characteristic animals of that country in their natural state.

The next Meeting of the Society for Scientific Business will be held on Tuesday, March 21st, 1916, at half-past FIVE o'clock P.M., when the following communications will be made :—

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J. T. CUNNINGHAM, M.A., F.Z.S.

Exhibition of skins illustrating results of Mendelian Cross in Fowls.

R. I. POCKOCK, F.R.S., F.L.S., F.Z.S.

Lantern-exhibition to show structure of the Alisphenoid Canal in some Civets and Hyænas.

T. GOODEY, D.Sc.

Observations on the Cytology of Flagellates and Amœbæ obtained from old stored Soil.

Major R. MEINERTZHAGEN, F.Z.S.

Notes on the Sitatunga or Marsh-Antelope of the Sesse Islands.

The following papers have been received :—

G. A. BOULENGER, F.R.S., F.Z.S.

1. On Specimens of the Perciform Fish, *Tilapia nilotica*, with Increased Number of Anal Spines.
2. On the Lizards allied to *Lacerta muralis*.

ROBERT GURNEY, M.A., F.Z.S.

On some Fresh-water Entomostraca from Ceylon.

R. I. POCKOCK, F.R.S., F.L.S., F.Z.S.

On the External Characters of the Mongooses (Mungotidæ).

Dr. H. MUIR EVANS.

The Poison-Organ of the Sting-Ray (*Trygon pastinaca*).

Dr. J. C. MOTTRAM.

1. Methods of estimating the Size of Fish from the Size of their Scales.
 2. Experimental Determination of the Factors which cause Patterns to appear conspicuous in Nature.
-

The Publication Committee desire to call the attention of those who propose to offer Papers to the Society, to the great increase in the cost of paper and printing. This will render it necessary for the present that papers should be condensed, and be limited so far as possible to the description of new results.

Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,

Secretary.

ZOOLOGICAL SOCIETY OF LONDON,

REGENT'S PARK, LONDON, N.W.

March 14th, 1916.

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

March 21st, 1916.

Dr. S. F. HARMER, F.R.S., Vice-President,
in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

THE SECRETARY read a Report on the Additions made to the Society's Menagerie during the month of February 1916.

Mr. E. T. NEWTON, F.R.S., F.Z.S., exhibited the pelt and bones of a Black Hare, for which he was under obligation to Mr. G. F. Brooke of Leadenhall Market, who had received it with a large consignment of Brown Hares from Siberia; but, unfortunately, the locality was not known. This hare is of small size and with short rabbit-like ears. The head and back are black excepting only a small white spot on the forehead; and towards the sides there are numerous long hairs with white tips. Lower down upon the sides the fur becomes tawny and passes into white underneath. All the feet, but especially the hinder ones, have light brown hair up the upper parts.

The skull and limb bones show characters agreeing with those of the hare; but in size the animal was intermediate between our common hare and the rabbit.

Mr. D. M. S. WATSON, F.Z.S., gave an account of some observations he had made on the habits and life-history of *Platypus* and *Echidna*.

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Mr. R. I. Pocock, F.R.S., F.Z.S., Curator of Mammals, gave an exhibition, illustrated by lantern-slides, to show some points connected with the alisphenoid canal in the Viverridæ and Hyænidæ, and demonstrated: (1) that the canal is always present in *Viverricula*, its occasional apparent absence in that animal being due to the closure of its posterior orifice near the *foramen rotundum*, which opens into the posterior end of the canal; (2) that the canal may be complete in *Crocuta*, as Cuvier stated, or may be closed at its posterior end.

Dr. T. GOODEY read a paper entitled "Observations on the Cytology of Flagellates and Amœbæ obtained from old stored Soil." This paper deals with the cytology and nuclear changes during division of three species of Flagellates and two species of Amœbæ obtained from soil stored in bottles at the Rothamsted Laboratory for practically fifty years. One of the Flagellates and the two Amœbæ are new to science.

The next Meeting of the Society for Scientific Business will be held on Tuesday, April 4th, 1916, at half-past FIVE o'clock P.M., when the following communications will be made:—

D. SETH-SMITH, F.Z.S.

Exhibition of a small Intensive Poultry House.

Prof. J. P. HILL, D.Sc., F.R.S., F.Z.S.

Exhibition of living Cæcilians from South America.

G. A. BOULENGER, F.R.S., F.Z.S.

1. On Specimens of the Perciform Fish, *Tilapia nilotica*, with Increased Number of Anal Spines.

2. On the Lizards allied to *Lacerta muralis*, with an Account of *Lacerta agilis* and *L. parva*.

ROBERT GURNEY, M.A., F.Z.S.

On some Fresh-water Entomostraca from Ceylon.

Major R. MEINERTZHAGEN, F.Z.S.

Notes on the Sitatunga or Marsh-Antelope of the Sesse Islands.

The following Papers have been received :—

R. I. POCKOCK, F.R.S., F.L.S., F.Z.S.

On the External Characters of the Mongooses (Mungotidæ).

Major H. MUIR EVANS, M.D., R.A.M.C.

The Poison-Organ of the Sting-Ray (*Trygon pastinaca*).

Dr. J. C. MOTTRAM.

An Experimental Determination of the Factors which cause Patterns to appear conspicuous in Nature.

The Publication Committee desire to call the attention of those who propose to offer Papers to the Society, to the great increase in the cost of paper and printing. This will render it necessary for the present that papers should be condensed, and be limited so far as possible to the description of new results.

Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,

Secretary.

ZOOLOGICAL SOCIETY OF LONDON,

REGENT'S PARK, LONDON, N.W.

March 28th, 1916.

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	II. }	

NOTICE.

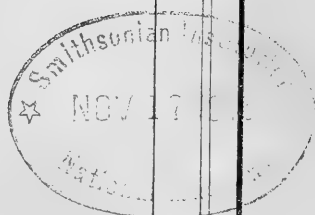
The 'Proceedings' for the year are issued in *four* parts, paged consecutively, so that the complete reference is now P. Z. S. 1916, p. . . . The Distribution is as follows:—

Part	I.	issued in March.
"	II.	" June.
"	III.	" September.
"	IV.	" December.

'Proceedings,' 1915, Part IV. (pp. 541-712), were published on
December 24th, 1915.

The Abstracts of the 'Proceedings,' Nos. 151-154, are
contained in this Part.

PROCEEDINGS
OF THE
GENERAL MEETINGS FOR SCIENTIFIC BUSINESS
OF THE
ZOOLOGICAL SOCIETY
OF LONDON.
1916.



PART II.
CONTAINING PAGES 309 TO 448, WITH 7 PLATES
AND 45 TEXT-FIGURES, TITLEPAGE, INDEX, ETC.

JUNE 1916.

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ZOOLOGICAL SOCIETY OF LONDON.

THIS Society was founded in 1826 by Sir STAMFORD RAFFLES, Mr. J. SABINE, Mr. N. A. VIGORS, and other eminent Naturalists, for the advancement of Zoology and Animal Physiology, and for the introduction of new and curious subjects of the Animal Kingdom, and was incorporated by Royal Charter in 1829.

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The Society consists of Fellows, and Honorary, Foreign, and Corresponding Members, elected according to the By-Laws. It carries out the objects of its foundation by means of its collection of living animals, by its Library, and by its Scientific Publications.

The Office of the Society, Regent's Park, N.W., where all communications should be sent, addressed to "The Secretary," is open from Ten till Five, except on Saturdays, when it closes at ONE P.M.

The Library, under the superintendence of Mr. Henry G. J. Peavot, is open daily (except Sunday) from Ten A.M. till Five P.M.; on Saturdays, Ten A.M. till Two P.M.

The Library is closed from Good Friday to Easter Monday, and upon all other Bank Holidays. It is also closed annually for cleaning purposes during the whole month of September.

The Meetings of the Society for General Business are held in the Meeting Room at the Society's Office on the third Wednesday in every month of the year, except in September and October, at half-past Four o'clock P.M.

The Meetings for Scientific Business are held in the Meeting Room at the Society's Office fortnightly on Tuesdays, except in July, August, September, and December and January, at half-past Five o'clock P.M.

The Anniversary Meeting is held on the 29th. of April, or the nearest convenient day, at Four P.M.

The Society's Gardens are open daily from Nine o'clock until Sunset. Mr. R. I. Pocock, F.R.S., F.L.S., is the resident Superintendent and Curator of Mammals, Mr. D. Seth-Smith is Curator of Birds and Inspector of Works, Mr. E. G. Boulenger is Curator of Reptiles, Prof. H. M. Lefroy is Curator of Insects, and Professor H. G. Plimmer, F.R.S., M.R.C.S., is Pathologist. Applications for anatomical material or facilities for work in the Prosectorium should be addressed to the Secretary of the Society.

TERMS FOR THE ADMISSION OF FELLOWS.

FELLOWS pay an Admission Fee of £5, and an Annual Contribution of £3, due on the 1st. of January, and payable in advance, or a Composition of £45 in lieu thereof; the whole payment, including the Admission Fee, being £50.

No person can become a FELLOW until the Admission Fee and first Annual Subscription have been paid, or the annual payments have been compounded for.

FELLOWS elected in November and December are not liable for the Subscription for the year in which they are elected.

PRIVILEGES OF FELLOWS.

FELLOWS have Personal Admission to the Gardens upon signing their names in the book at the entrance gate, and may introduce Two Companions daily.

The WIFE or HUSBAND of a FELLOW can exercise these privileges in the absence of the Fellow.

Until further notice, FELLOWS will receive 40 undated Green Cards, available on any Sunday or week-day up to the end of February of the year following the year of issue, and 20 White Cards available on any week-day up to the same date. Twenty of the Green Cards may be exchanged for a book containing two Orders for each Sunday in the year. Twenty White Cards may be exchanged for a book of dated Week-day Orders, each Order available for any day during the week except Sunday. Special children's tickets are no longer issued, but the Green and White Cards are perforated, and each half is valid for a Child under twelve years of age. It is particularly requested that Fellows *will sign every ticket* before it goes out of their possession. Unsigned tickets are not available.

FELLOWS are not allowed to pass in friends on their written order or on presentation of their visiting cards.

FELLOWS have the privilege of receiving the Society's ordinary Publications issued during the year upon payment of the additional Subscription of One Guinea. This Subscription is due upon the 1st. of January, and must be paid before the day of the Anniversary Meeting, after which the privilege lapses. FELLOWS are likewise entitled to purchase these Publications at 25 per cent. less than the price charged to the public. A further reduction of 25 per cent. is also made upon all purchases of Publications issued prior to 1881, if above the value of Five Pounds.

FELLOWS also have the privilege of subscribing to the Annual Volume of 'The Zoological Record,' which gives a list of the Works and Publications relating to Zoology in each year, for the sum of One Pound Ten Shillings. Separate divisions of volumes 39 to 42 can also be supplied. Full particulars of these publications can be had on application to the Secretary.

FELLOWS may obtain a TRANSFERABLE IVORY TICKET admitting two persons, available throughout the whole period of Fellowship, on payment of Ten Pounds in one sum. A second similar ticket may be obtained on payment of a further sum of Twenty Pounds.

Any FELLOW who intends to be absent from the United Kingdom during the space of at least one year, may, upon giving to the Secretary notice in *writing*, have his or her name placed upon the "dormant list," and will then be called upon to pay an annual subscription of £1 only during such absence, but after three years must make a further application to be retained on that list.

Any FELLOW, having paid all fees due to the Society, is at liberty to withdraw his or her name upon giving notice in *writing* to the Secretary.

Ladies or Gentlemen wishing to become Fellows of the Society are requested to communicate with "The Secretary."

P. CHALMERS MITCHELL,

Secretary.

Regent's Park, London, N.W.
June, 1916.

MEETINGS

OF THE

ZOOLOGICAL SOCIETY OF LONDON

FOR

SCIENTIFIC BUSINESS.

1916.

TUESDAY, OCTOBER 24.
,, NOVEMBER 7 and 21.

The Chair will be taken at half-past Five o'clock precisely.

ZOOLOGICAL SOCIETY OF LONDON.

THE ZOOLOGICAL RECORD.

THE ZOOLOGICAL RECORD gives, by means of an annual Volume, complete lists of the Works and Publications relating to Zoology that have appeared during the year preceding the issue of the Volume, together with a Subject and a Systematic Index.

Since 1906 the ZOOLOGICAL RECORD has been amalgamated with the Zoology volume of the International Catalogue of Scientific Literature, and has appeared in two forms, different only in title-page and binding, one in series with the Zoological Record, the other forming Volume N, Zoology, of the Annual Issue of the International Catalogue.

On account of difficulties arising from the War, the Executive Committee of the International Catalogue is at present unable to undertake the issue of any volumes of the 15th Annual Issue. The Zoological Society of London, in these special circumstances, has undertaken to produce the Zoological Record as usual, precisely in accordance with the form that the volume has assumed since the amalgamation.

Fellows of the Zoological Society, and Institutions already on its subscription-list, and any new subscribers whose subscriptions are received before August 1st, 1916, will receive the volume dealing with the literature for 1915 (Zoological Record, Vol. 52: International Catalogue, 15th Annual Issue, N, Zoology) as usual at the end of the year or early in 1917.

The Society is able to supply complete sets of the Record on the following terms:—

Vols. 1 to 42, price £16 10s. net. Vol. 43 and onwards at 40s. each.

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Index Zoologicus. An alphabetical list of names of genera and subgenera proposed for use in Zoology, as recorded in the 'Zoological Record,' 1880–1900; together with other names not included in the 'Nomenclator Zoologicus' of S. H. Scudder. Compiled (for the Zoological Society of London) by CHARLES OWEN WATERHOUSE and edited by DAVID SHARP, Editor of the 'Zoological Record.' London, 1902. Price to Fellows, 18s.; price to the public, 20s., or if sold with a set of the 'Zoological Record,' 10s.

Index Zoologicus, No. II. An alphabetical list of names of genera and subgenera proposed for use in Zoology, as recorded in the 'Zoological Record,' Vols. 38–47 inclusive (1901–1910), and the Zoology volumes of the 'International Catalogue of Scientific

Literature,' Annual Issues 1-10. Compiled (for the Zoological Society of London) by CHARLES OWEN WATERHOUSE, I.S.O., and edited by DAVID SHARP, M.A., F.R.S., Editor of the 'Zoological Record.' London, 1912. Price to Fellows, 12s. 6d. net; price to the public, 15s. net., or if sold with a set of the 'Zoological Record,' 10s.

SEPARATE DIVISIONS OF THE ZOOLOGICAL RECORD.

Divisions of Vols. 39 to 42 and Vols. 51 and 52 of the 'Zoological Record' can be supplied by the Society, but those of Vols. 43 to 50 can be had only from Messrs. Harrison & Sons, 46 St. Martin's Lane, W.C.

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P. CHALMERS MITCHELL,

Secretary.

REGENT'S PARK, LONDON, N.W.

June, 1916.

ZOOLOGICAL SOCIETY OF LONDON.

LIST OF PUBLICATIONS.

THE scientific publications of the Zoological Society of London are of two kinds—"Proceedings," published in an octavo form, and "Transactions," in quarto.

According to the present arrangements, the "Proceedings" contain not only notices of all business transacted at the scientific meetings, but also all the papers read at such meetings and recommended to be published in the "Proceedings" by the Committee of Publication. A large number of coloured plates and engravings are issued in the volumes of the "Proceedings," to illustrate the new or otherwise remarkable species of animals described therein. Amongst such illustrations, figures of the new or rare species acquired in a living state for the Society's Gardens are often given.

The "Proceedings" for each year are issued in four parts, pagged consecutively, during the months of March, June, September, and December. From January 1901 they have been issued as two half-yearly volumes, indexed separately.

An "Abstract of the Proceedings" is published by the Society on the Tuesday following the date of the Scientific Meeting to which it refers. It is issued along with the "Proceedings," free of extra charge, to all Fellows who subscribe to the Publications, but it may be obtained on the day of publication at the price of Sixpence, or, if desired, sent post free for the sum of Six Shillings per annum, payable in advance.

The "Transactions" contain such of the communications made to the Scientific Meetings of the Society as, on account of the nature of the plates required to illustrate them, are better adapted for publication in the quarto form. They are issued at irregular intervals.

Fellows and Corresponding Members, upon payment of a Subscription of One Guinea *before* the day of the Anniversary Meeting, are entitled to receive the Society's Publications for the year. They are likewise entitled to purchase the Publications of the Society at 25 per cent. less than the price charged to the Public. A further reduction of 25 per cent. is made upon purchases of Publications issued prior to 1881, if they exceed the value of Five Pounds.

Fellows also have the privilege of subscribing to the Zoological Record for a sum of One Pound Ten Shillings (which includes cost of delivery), payable on the 1st. of July in each year; but this privilege is forfeited unless the subscription be paid *before* the 1st of December following.

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„	XV., „	52	„ .. (1898-1901) ..	5	15	6	7	14	0
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„	XVIII., „	43	„ .. (1907-1911) ..	4	1	0	5	8	0
„	XIX., „	24	„ .. (1909-1910) ..	10	4	0	13	12	0
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In consequence of a re-arrangement of the stock of the 'Transactions,' the Society is now able to offer for sale, at the reduced price of £30, sets of Vols. V.-XVI. inclusive, and separate papers, of which a list can be supplied, at about one-fourth their published price.

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List of the Vertebrated Animals now or lately Living in the Gardens of the Zoological Society of London. (Eighth Edition.) 8vo. 1883. Cloth, 4s. 6d.

List of the Vertebrated Animals now or lately Living in the Gardens of the Zoological Society of London. (Ninth Edition.) 8vo. 1896. Cloth, 6s.

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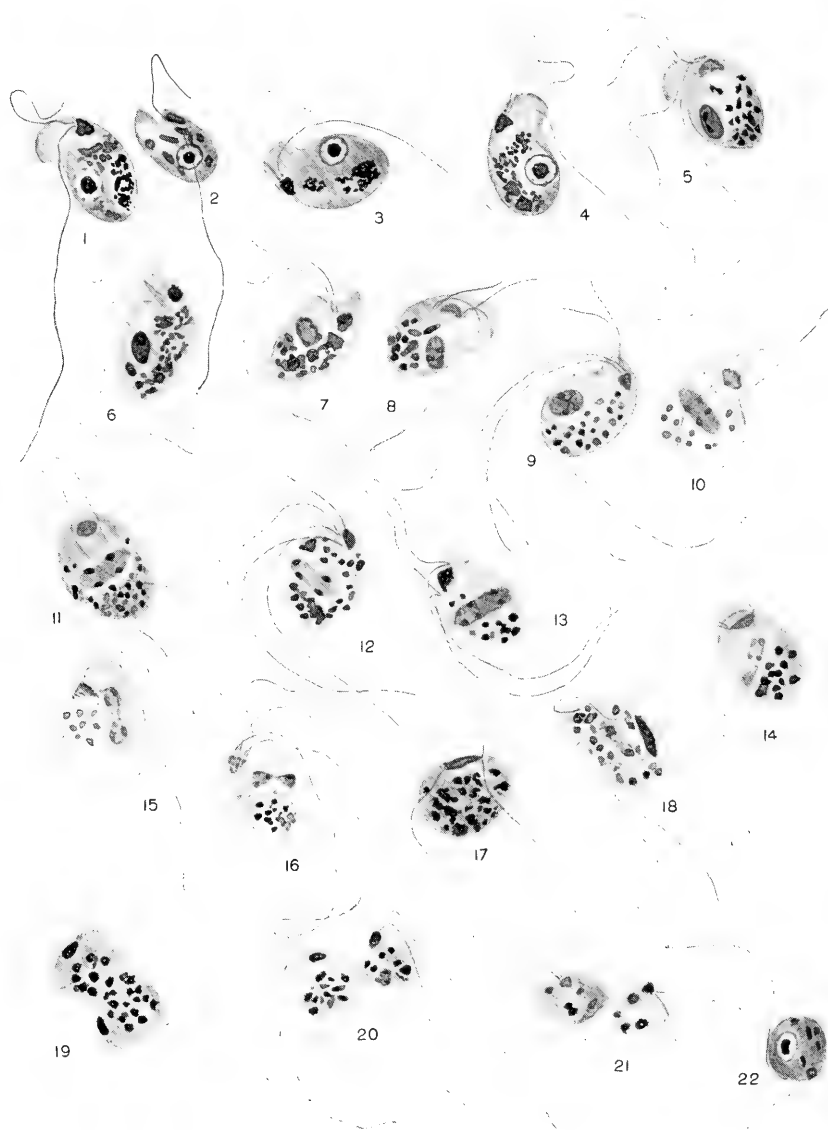
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P. CHALMERS MITCHELL,
Secretary.

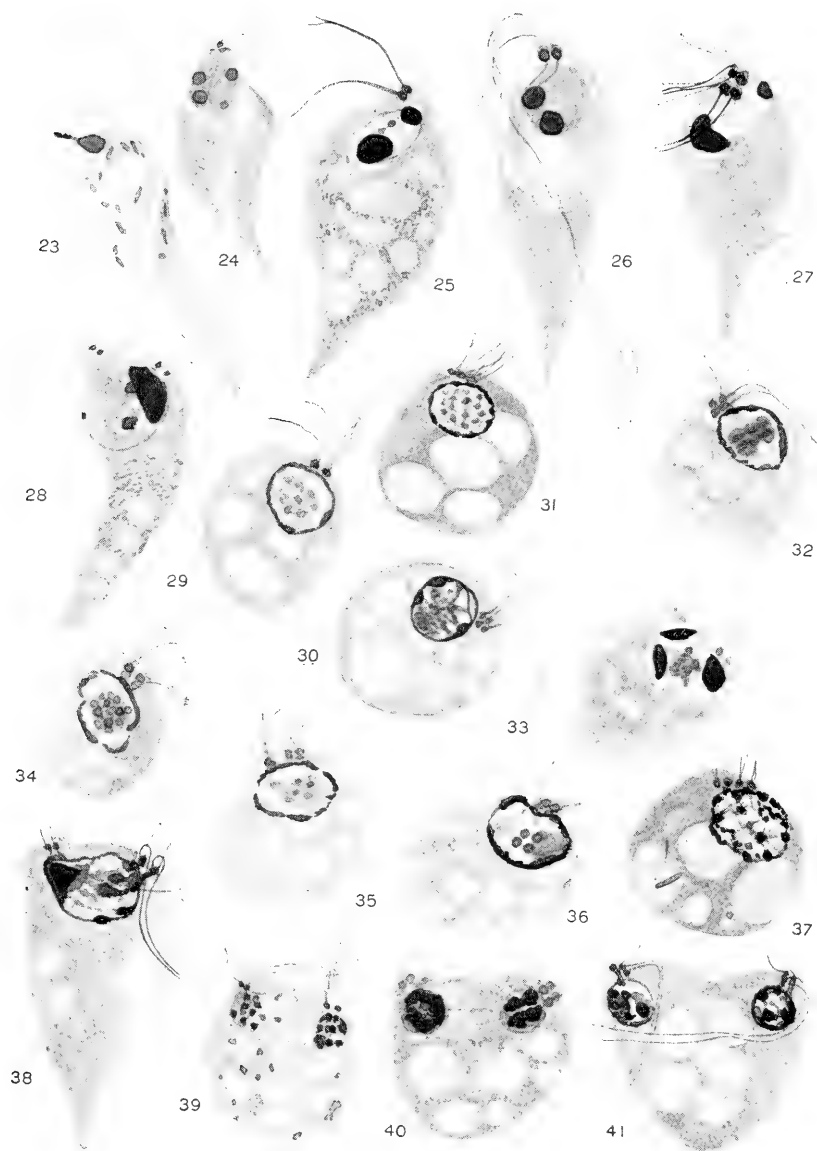
Regent's Park, London, N.W.
June, 1916.

*These publications may be obtained at the SOCIETY'S OFFICE
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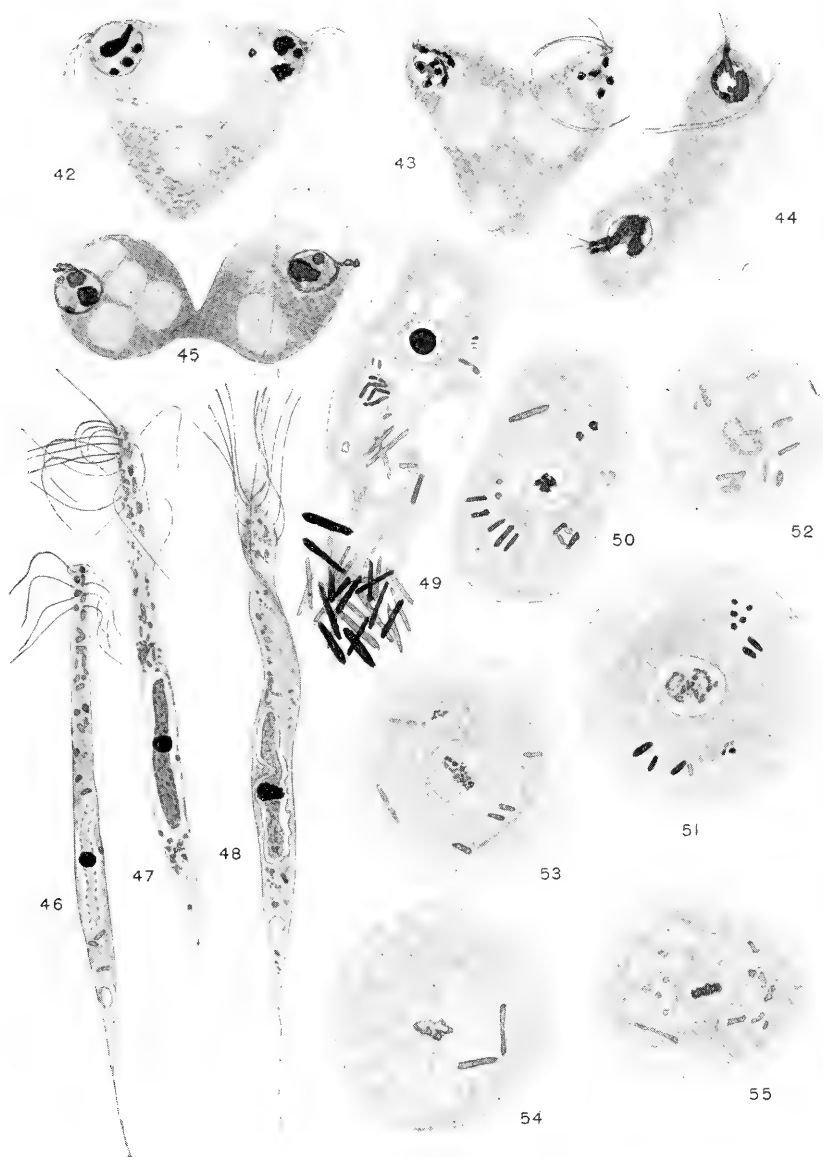
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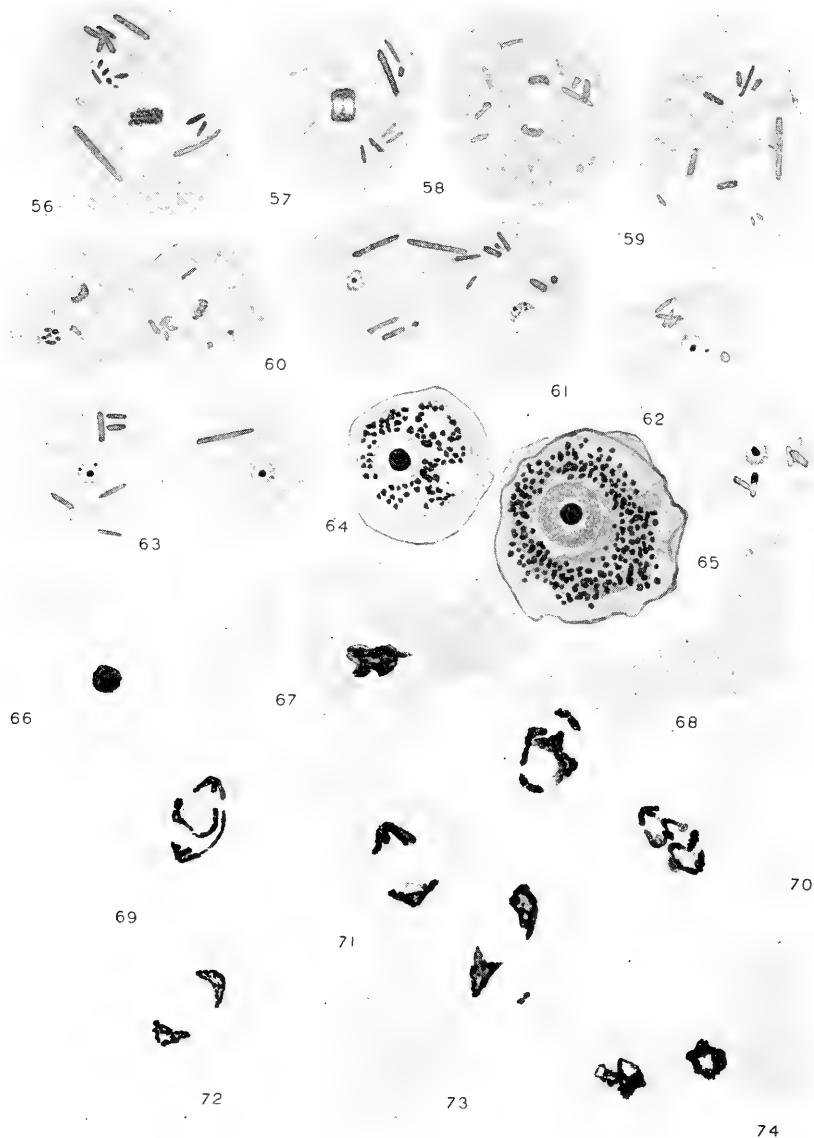
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PAPERS.

8. Observations on the Cytology of Flagellates and Amœbæ obtained from old Stored Soil. By T. GOODEY, D.Sc.*, Protozoologist, Research Laboratory in Agricultural Zoology, University of Birmingham.

[Received February 3, 1916; Read March 21, 1916.]

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INTRODUCTION.

Within the last few years a good deal of attention has been paid to soil-protozoa, owing to the important function ascribed to them by Russell and Hutchinson† in their hypothesis advanced to account for the changes observed on partially sterilising soil. According to these investigators, soil-protozoa act as a factor limiting bacterial activity, and so prevent a normal soil from attaining its full fertility.

It is of importance, therefore, that we should ascertain what kinds of protozoa are present in the soil and as much as possible

* Communicated by Prof. F. W. GAMBLE, F.R.S., F.Z.S.

† Russell and Hutchinson, Journ. Agric. Sci. vol. iii. pt. xi. (1909), and vol. v. pt. xi. (1913).

of their life-histories; also whether they are forms capable of consuming bacteria, and thus able to function as a limiting factor on soil-bacteria.

One of the chief methods by which soil-protozoa can be studied is examination in cultures made in suitable media; and although it has recently been claimed* that the cultural forms are not necessarily those occurring in a trophic condition in the soil, and may not therefore be concerned in the biological changes of the soil, yet I have quite recently obtained some experimental results which point most positively to the cultural protozoa, especially amœbæ, acting as a check to the increase of bacterial numbers. I hope to publish an account of this work shortly. In the present paper an account is given of a few forms of flagellates and amœbæ which were obtained culturally from some old soils stored at Rothamsted Experimental Station, together with some observations on their cytology and methods of division. The protozoan fauna of these soils was a limited one when compared with that of an ordinary garden or field-soil, and for this reason presented a suitable field for working out the different organisms in detail.

In a recent number of 'The Annals of Applied Biology' I have recorded the culture of amœbæ and flagellates from soil bottled so far back as 1865 and left untouched since then; thus proving the survival of protozoa, no doubt in an encysted condition, for a period of 49 years. It was my intention at the outset of the work merely to obtain an idea of the character of the protozoan fauna surviving in the different soils examined. In order to do this, and to determine as nearly as possible the different species which cropped up, it was necessary to make a number of permanent stained preparations and to study these in considerable detail. As a result of these observations, I have obtained a number of interesting facts on the cytology, mode of nuclear division, etc., in several of the forms examined.

The samples of soil tested for protozoa were taken from bottles of soil obtained originally from five of the fields under experimental cultivation at Rothamsted. These were: Broadbalk soil bottled in 1865, Geescroft soil bottled in 1865, Agdell soil bottled in 1867, Hoosfield soil bottled in 1868, and Barnfield soil bottled in 1870.

METHODS.

As a culture medium, saline egg-albumen was used and found very serviceable. A small quantity of soil was placed in this medium, contained in a circular flat-bottomed glass dish furnished with a close-fitting flat lid. This was then put into an incubator at 22° C., or left at room-temperature. After a few days, microscopic examination of the culture revealed active protozoa. These were frequently found on the surface or at the bottom of the

* Russell, E. J., "Soil Protozoa and Soil Bacteria," Proc. Roy. Soc. B, vol. lxxxix. p. 76 (1915).

liquid; and in order to obtain these forms, coverslips were floated on the surface and placed on the bottom. In other cases the vast majority of the organisms occurred about midway in the depth of the culture, and in order to obtain coverslip-preparations of these I drew out small quantities of the culture where the protozoa were thickest by means of a fine pipette, and then made smears with the liquid. As a rule, three cultures were made from each soil, in order to obtain a representative fauna, and the cultures were examined for several days to note any succession of forms. Coverslip-preparations were fixed in Maier's solution or in Bouin's fixative, and iron-haematoxylin was used as the stain throughout; occasionally preparations were counterstained with lichtgrün-picric.

I propose in the following pages to deal with the protozoa encountered under the heading of the group to which they belong, mentioning the particular soil or soils from which they were taken.

A. FLAGELLATA.

(1) PROWAZEKIA (BODO) SALTANS Ebrbg. (Pl. I.)

In one of my cultures of Barnfield 1870 soil a very small jumping flagellate occurred in abundance at the bottom of the liquid. It appeared somewhat bean-shaped when seen under a low power, and I at once concluded that it was *Bodo saltans*. A coverslip-preparation was made, and on it I obtained many dividing organisms, from a study of which I have been able to work out fairly completely the process of nuclear division. I will describe the structure of a normal organism, and then deal with the question of identification and nomenclature.

(a) *Structure.*

The body is somewhat bean-shaped and is oval or round in cross-section. Seen from the ventral aspect—*i.e.* the side on which the flagella arise (fig. 1)—the anterior end appears flattened and is turned towards the left, where it terminates in an almost straight edge. This anterior portion of the organism is really an extension of the dorsal region, and is separated on the ventral surface from the main part of the body by a considerable depression, in which the mouth is situated. Fig. 2 shows a side-view and the relations of the anterior end to the depression, etc.

The trophonucleus is generally found towards the left side of the body when the organism is viewed from the ventral surface. It consists of a central deeply staining karyosome, which is connected with the nuclear membrane by means of strands which stretch across the extra-karyosomic zone, and at their insertion on the membrane produce slight thickenings.

The kinetonucleus is an irregular granular mass, often somewhat triangular in outline, and, on the whole, stains less intensely

than the karyosome of the trophonucleus. It has no nuclear membrane and is situated towards the ventral surface, close to the upper end of the mouth-depression. Its position can readily be made out in figs. 1 & 2.

The two flagella arise close to the anterior surface of the kintonucleus from very indistinct blepharoplasts. The anterior flagellum is the shorter of the two, the posterior one being two or two and a half times its length. The organism ingests bacteria, which no doubt serve as a source of food, for the protoplast is often packed with cocci and other small forms of bacteria.

(b) *Reproduction.*

The first indication of approaching division which I have been able to find is the doubling of the anterior flagellum (fig. 4). At this stage no change is visible in the appearance of the nuclei. I am unable to say how the flagella become duplicated, but, judging from the fact that I have found no organisms showing protrusions like flagellar buds, and also that when the flagella become doubled the members of each pair are equal in length, I am inclined to the view that the original flagella split longitudinally.

The posterior flagellum becomes doubled later than the anterior one, and at this time the trophonucleus shows a marked change in appearance. The karyosome becomes much reduced in volume and divides into two equal parts, whilst at the same time the connecting strands between it and the nuclear membrane disappear. The nucleus elongates a little and stains rather more deeply, doubtless owing to the liberation of a chromatinic substance from the karyosome (figs. 5 & 6). Irregular granules of chromatin now appear at the periphery of the nucleus as the result of further fragmentation of the karyosome, and become concentrated towards the equatorial region. This particular stage is very difficult to determine, and I cannot say whether an equatorial plate is produced. So far as I can make out, there is merely an aggregation of chromatin granules on the surface of the nucleus in this region. These granules finally concentrate into four principal larger ones, which are arranged in two pairs. The stage figured on fig. 9 shows them apparently connected by two crossing strands. The nucleus now elongates, each end being somewhat pointed, and each pair of granules becomes drawn towards opposite ends of the nucleus. These stages are shown in figs. 10, 11, & 12. Soon after this a constriction appears in the middle of the nucleus, which now becomes rather dumb-bell-shaped (fig. 15). At about the same time, or even earlier, the four granules of chromatin begin to show signs of breaking down, and also stain less intensely (figs. 13-16). The constriction at the centre of the nucleus becomes carried still further, until two triangular daughter-nuclei are formed, each of which contains rather faintly staining chromatin granules. I have found it impossible to trace the later stages in the reorganisation of the daughter-nuclei, owing

to the fact that the flagellates are almost always crowded with deeply staining bacteria which obscure the nuclear elements. The next stage of the trophonucleus which I have certainly made out, is that in the daughter-organisms where the granules have become concentrated again into a central karyosome separated from the nuclear membrane by a clear zone (fig. 21). Whilst the above changes are proceeding, the kinetonucleus undergoes certain alterations. It increases in volume, and may either be triangular or rhomboidal in outline. One pair of flagella moves to either side of it, and at these points the kinetonucleus becomes somewhat drawn out. Soon after the formation of daughter-trophonuclei has taken place, the kinetonucleus elongates considerably, so that the pairs of flagella are carried farther apart. This elongation is carried on until a fairly long band of kinetonuclear material is produced, which finally separates into two portions—the daughter-kinetonuclei. I have not found the stages showing the constriction and division of the kinetonucleus, but there can be no doubt, I think, that the process is simple and direct.

Concurrently with the elongation of the kinetonucleus, the body of the flagellate becomes oval and then grows laterally, so that the longer axis of the body is that running from side to side, not antero-posteriorly. Division of the body is initiated by the formation of a constriction on the now shorter axis of the body, and becomes more and more pronounced until the two daughter-organisms are connected only by a short narrow strand of protoplasm. This finally breaks, and the two small organisms are produced. Division thus takes place along the antero-posterior axis of the body, and is therefore longitudinal.

(c) *Systematic Position.*

Because of the rapid spasmodic jumping motion exhibited by this organism in life, the name *saltans* is eminently applicable to it. From its general shape also, and the presence of two flagella, the posterior one being longer than the anterior, it easily fits into the genus *Bodo*. The difficult point to determine, however, is whether it should be classified as a *Bodo* or as a *Prowazekia*, for it possesses a kinetonucleus.

Alexeieff ('11 & '12) is of the opinion that all the species of *Bodo* possess a kinetonucleus, and holds that the genus *Prowazekia* is untenable. According to this author, my organism should go in the genus *Bodo*. I am not convinced, however, that his assertion concerning the presence of a kinetonucleus in *Bodo* is correct, for I have obtained a bmastigote form having the anterior flagellum shorter than the posterior one in which there is certainly no kinetonucleus, and which undoubtedly belongs to the genus *Bodo*. I therefore propose to place my organism in the genus *Prowazekia*. At the same time, however, I insert the name *Bodo* in brackets, because I think this form is identical with *Bodo saltans*. Alexeieff

('11) gives the dimensions of *Bodo saltans* as 6–10 μ in length by 3–5 μ in breadth. My organism is much smaller than this, measuring from 5–6 μ in length by 2·5–4 μ in breadth. In this respect it comes nearest to *Bodo minimus* Klebs, which is from 4–5 μ in length and is considered to be one of the smallest flagellates. The latter form, according to its original describer, is changeable in shape and has a creeping movement. My organism is very constant in shape, and always moves in rapid jumps followed by intervals of rest. There can be no doubt, then, that its specific name should be *saltans*.

Alexeieff ('11, p. 508) says that, without a doubt, *Bodo saltans* is the same organism as *Prowazekia parva* described by Nägler ('10). The latter organism differs considerably from that described above in several respects. Its protoplast is labile and takes on a great variety of shapes, whereas my organism is constantly bean-shaped. The method of division in both the tropho- and kinetonucleus is quite different from that described above. There is no fragmentation of the karyosome of the trophonucleus with the ultimate formation of four chromatin granules or chromosomes, but merely an equal division of the karyosome by promitosis, a centriole and a centrodosome taking part in the process. The kinetonucleus divides in a similar manner. It is obvious, therefore, that Nägler's organism is a species distinct from mine, and his name *Prowazekia parva* should be allowed to remain.

Among the descriptions of members of the genus *Prowazekia* by Hartmann & Chagas ('10), Nägler ('11), Mathis & Léger ('10), Withmore ('11), Martin ('13), and Bělár ('14), the division of the trophonucleus of *Prowazekia asiatica* by Withmore comes nearest to that which I have given in the foregoing account. His figs. 18 and 19 show the presence of four principal chromosomes in the dividing nucleus, which, however, differs considerably in its earlier division stages from those observed in my organism.

(2) TETRAMITUS SPIRALIS, sp. n. (Pls. II., III., figs. 23–45.)

(a) Structure.

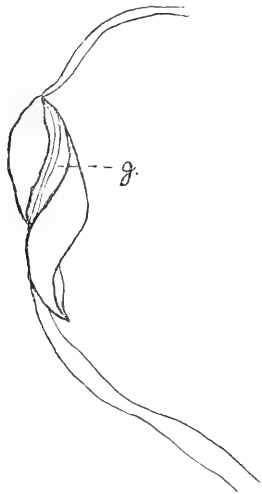
This interesting organism occurred in cultures from three different soils, viz.: Agdell 1867, Broadbalk 1865, and Barnfield 1870. I have been fortunate in obtaining it in large numbers, and have been able to make out most of the details of its structure and mode of division. I have not, however, observed it in the encysted condition, although I kept my cultures for a long time and had the organisms under close observation in hanging drops. I will first describe its structure and movements, and then deal with the process of reproduction.

In the majority of cases the body is pyriform in shape, having its extreme anterior end somewhat pointed. It may, however, become much elongated, and then appears more cylindrical.

A groove runs spirally from the anterior to the posterior end

of the body. Seen from the ventral aspect—*i. e.*, from the side on which the flagella arise (text-fig. 1)—the groove proceeds from right to left, and then curves round to the dorsal surface and reaches the posterior end of the body. If the body is of normal length there is only this one turn in the spiral, but if the organism is elongated there may be two turns. The accompanying text-figure, drawn from a specimen immediately after killing with osmic-acid vapour, shows the shape of the organism, the position of the groove, and the disposition of the flagella. The latter are arranged in two pairs—a shorter anterior pair and a longer posterior pair. The anterior pair is directed forwards during motion and the posterior pair is trailed backwards.

Text figure 1.

*Tetramitus spiralis.*

Outline drawing as seen in ventral view, showing the relations of the groove (*g.*).

The members of each pair are frequently very closely applied, and often appear as one thick flagellum. When in active movement, which is caused by the lashing of the anterior pair of flagella, the organism progresses very rapidly and rotates on its long axis. The posterior pair of flagella appears to lie within the groove and extends beyond the posterior end of the organism, which swings from side to side of the line of motion owing to the rapidity of progression. The mouth is very difficult to locate, being ill-defined, but in certain examples I have made out its position a short distance from the anterior end as a depression in the groove. Bacteria are ingested and no

doubt serve as a source of food. There does not appear to be a contractile vacuole. The body measures from 8–12 μ in length.

Fixed and stained material shows that the protoplasm is alveolar in structure, and that the nucleus is situated at the anterior end of the body, as in *Trichomonas* and *Trichomastix* and similar forms. The nucleus is a vesicular structure of variable size, but often of quite large dimensions. There is no central karyosome, but the chromatin is disposed irregularly in two or more masses. Very frequently there are two semilunar blocks of chromatin situated on either side or on the anterior and posterior borders of the nucleus. It will be seen from the figures in what an irregular fashion the chromatin is arranged.

The flagella arise from blepharoplasts placed just anteriorly to the nucleus. They are four in number and, as stated above, are disposed in two pairs. They take their origin in four blepharoplasts, which when seen in side view (fig. 25) appear as two large granules in contact with each other, but when seen in face view are easily recognisable as being a group of four distinct granules in intimate contact (figs. 26 & 27). The posterior pair of granules is connected with the nucleus by means of two rhizoplasts, which appear as one short rod in fig. 25 but are well shown in the ventral view obtained in fig. 26. I made a very careful examination of this region, in order to determine if rhizoplasts were present connecting the anterior pair of blepharoplasts with the nucleus, and I am satisfied that the pair connecting the posterior blepharoplasts is the only one.

(b) *Reproduction.*

I will deal first with the multiplication of the flagella, because this always occurs prior to the division of the nucleus. The new flagella are produced by outgrowths from the body of the organism, and not by splitting of the old flagella. In this it resembles *Copromonas*, *Trichomonas*, and many other flagellates. The process is initiated by the growth in an anterior direction of each pair of blepharoplasts: a point very difficult to make out in many of the organisms, but well shown in other cases, one of which is represented in fig. 27. The flagellar buds arise as delicate hair-like outgrowths from the developing buds of the blepharoplasts. Each pair of flagella has thus a new pair of flagella produced immediately anterior to it. The new ones do not stain so deeply as the old flagella, as will be seen from the figures representing different stages of the division of the nucleus. In this way the original posterior pair acquires a new anterior pair, and the original anterior pair grows longer and becomes the posterior pair of one of the daughter-organisms, at the same time acquiring a new anterior pair. The four pairs of flagella thus produced gradually separate into two sets of two pairs, which finally come to take up positions at either end of the anterior face of the nucleus; but this migration takes place at different periods during the progress of nuclear

division. For example, fig. 28 shows an organism in which the flagella are widely separated, although the nucleus shows no sign of approaching division. I am unable to state the fate of the pair of rhizoplasts.

In the earliest stages in the division of the nucleus the chromatin seems to undergo some process of dissolution and reorganisation whereby certain parts of it, which stain less intensely than the rest, gradually come towards the centre of the nucleus. These take the form of roundish or irregular granules which, at the stage shown in fig. 31, appear to be arranged in a fairly regular manner on a kind of reticulum or network of linin threads. Whilst these changes are taking place, the remainder of the chromatin, having deeply staining properties, becomes arranged in the form of a ring round the periphery of the nucleus. This does not always happen in the very early stages, however, as is shown in fig. 33, where the deeply staining chromatin is still present as three blocks, whilst at the centre of the nucleus there is a group of lighter granules. The changes which occur in the lighter staining granules are very difficult to make out, but it seems as though they gradually concentrate towards the centre of the nucleus, and there become arranged in an irregular manner on a kind of plate. In figs. 32 and 33 there appear to be six principal granules disposed in two bands upon what seems to be a spindle formation. I do not wish, however, to lay stress on the presence of a spindle within the nucleus, for I have failed to make it out with any degree of distinctness, and even in those examples which present the spindle appearance, there are always irregularly-branching linin strands running in various directions, as shown in figs. 35 and 36.

In the stages represented in figs. 34-36, four principal round granules are present. These represent the nearest approach to chromosome formation in the whole series of changes. It would appear from these figures that the nucleus produces division centres from within, and is not dependent on the migration of the blepharoplasts to their antero-lateral positions for the formation of its poles of division. I have not been able to trace further the movements of the four internal chromosomes. In the succeeding stages the nucleus elongates somewhat laterally, and the peripheral ring of chromatin begins to break up and travel towards the lateral poles, at the same time advancing on to the dorsal and ventral surfaces of the nuclear membrane. In fig. 38 the connections between the blepharoplasts and the nucleus which ultimately become the rhizoplasts are fairly clearly seen. The lateral elongation of the nucleus now becomes more pronounced, and the chromatin, travelling along the linin threads of the nuclear network, becomes arranged in small granular masses towards the lateral poles. At this time the threads stretching across the centre of the nucleus can be made out fairly easily (figs. 39 & 40). These linin threads are doubtless absorbed, and two laterally situated daughter-nuclei are thus

produced. The chromatin now becomes re-arranged in granules of varying size and shape, as shown in figs. 41-44.

During the later stages of nuclear division, the anterior surface of the body becomes much drawn out and flattened. A depression now appears on this surface of the body and gradually travels backwards, and at the same time, in some cases, the protoplast extends laterally (fig. 44). In other cases the body becomes triangular in outline, and large vacuoles appear towards the centre of the body and, by rupturing, assist in the production of the daughter-organisms (figs. 42 & 43). Division of the body is thus longitudinal in direction. Fig. 45 shows two newly-formed organisms which have recently separated, their drawn-out tail-ends overlapping slightly.

(c) *Systematic Position.*

The possession of four flagella places my organism undoubtedly in the genus *Tetramitus* Perty, and though this to-day is a very mixed assemblage of forms, comprising, as it does, the free-living organisms described by Perty and by Klebs ('92), and also the parasitic forms *Tetramitus (Macrostoma) mesnili* (Wenyon, '10 a) and *Tetramitus (Macrostoma) caulleryi* (Alexeieff, '11 a), there is no reason why I should create a fresh genus for its reception. As, however, I have been unable to discover any description or figures of any free-living member of the genus which fits my organism, I have decided to make a new species of it, namely, *spiralis*.

(3) SPIRONEMA MULTICILIATUM Klebs. (Pl. III. figs. 46-48.)

(a) *Structure.*

This highly interesting organism occurred in one culture made from Broadbalk 1865 soil. It appeared both on the surface and at the bottom of the culture. My attention was first attracted to it by reason of its great length and its peculiar method of locomotion. It moved slowly in a very hesitating jerky manner for the most part, but would suddenly exhibit rapid and violent spiral twists commencing at its anterior end and travelling down the body, at which times it was propelled at a reasonably fast pace. It was obvious that the organelle causing the slow jerky motion were situated at or towards the anterior end, though they could not be distinguished under a low power of the microscope. Towards the posterior end a contractile vacuole could be seen in diastole and systole.

I was able to obtain film preparations which, when fixed and stained, revealed the structure of the organism very clearly. The body is extremely long in comparison with the width, and is dorso-ventrally flattened. It measures anything from 20-50 μ in length, and averages about 4 μ in width. The middle region is generally the widest part of the body. The anterior end is either rounded or has a lateral knob-like portion on either side.

The posterior end is drawn out into a long and exceedingly fine tapering tail, and the contractile vacuole occurs just where the body begins to narrow down.

The flagella are numerous and comparatively short. They vary in number from seven to eighteen, and the smaller the organism the fewer the flagella. They are situated in most cases in two lateral rows towards the anterior end of the body, one row being dorsally and the other ventrally placed. I have carefully noted the disposition and number of the flagella, and find that they are not equally distributed on either side, but exhibit a considerable amount of variation in this respect. Klebs, on his Pl. xvi. fig. 9 c, shows a row of flagella extending backwards on one side as far as the beginning of the tail. I have not found anything like this in my organisms.

A few of the organisms were fixed just as they were twisting spirally, and one of these is shown in fig. 48. It will be seen from this that the edges of the body are curved, and that the flagella have their origin close to the edges. Each flagellum arises from a small basal granule or blepharoplast distinctly seen in the stained material. I cannot say whether there is a mouth, and although I watched the creatures in life for a long time, I never saw them take in food. There are numerous large granular bodies, however, in the cytoplasm in many of the forms which appear to be ingested bacteria, and because of this, I am of the opinion that a mouth is present. I believe it is situated towards the anterior end, for I have made out, in some cases, a somewhat lighter area here which might be considered as the mouth. In the greater part of the body the cytoplasm is very finely granular and evenly distributed, but towards the posterior end, in the region of the contractile vacuole, it is frequently much vacuolated.

The nucleus is a very interesting structure. It is, in most cases, of considerable length, and is situated about half-way down the body. It consists of a long narrow rod of granular material, frequently one-quarter to one-third of the body in length. Towards the middle of it is placed a circular karyosome of deeply staining chromatin. The extra-karyosomic portion of the nucleus appears to be very little different from the general cytoplasm in staining reactions, and is separated from the latter on all sides by a very narrow clear space. There does not appear to be any nuclear membrane. At all events, I have not made out anything comparable with the nuclear membrane of other flagellates and amœbæ. From the appearance of the stained examples, it seems that all the chromatin is concentrated in the deeply staining karyosome, there being only small scattered granules in the rest of the nucleus.

The nearest approach to this nuclear apparatus which I have been able to find, is that which occurs in certain Euglenoidea, for example, in *Euglena viridis* (Keuten, '95), in which there is a fairly large nucleus consisting of a central karyosome

surrounded by a granular portion, the bulk of the chromatin being located in the karyosome, and the rest disposed in fairly large granules in the extra-karyosomic part. At first I was inclined to regard the extra-karyosomic portion of the nucleus as a macronucleus, and the karyosome as a micronucleus, taking the organism to be a ciliate. But the comparatively large size of the karyosome, and the fact that it occurs embedded in the centre of the rest of the nucleus, seems to rule out its micronuclear homology. Unfortunately, none of my preparations shows the organism dividing, so that I am unable to indicate the behaviour of the nucleus during these most important phases.

(b) *Systematic Position.*

After studying Klebs's ('92, p. 350) description and figures of the organism *Spironema multiciliatum*, there can be no doubt that my organism belongs to the same genus. It agrees in possessing about the same number of flagella, which are similarly situated, a posteriorly placed contractile vacuole, and in general appearance is the same. Klebs's organisms measured $14-18\ \mu$ in length by $2-3\ \mu$ in width, whilst none of my organisms is less than $20\ \mu$ in length, and they are about the same as his in width. This difference in length does not appear to me to be sufficiently important to warrant the creation of a new species for the reception of my organism. Klebs describes and figures two lateral spiral grooves commencing at the anterior end of the body and extending backwards as far as the beginning of the tail, and says that the flagella are inserted on the edge of each groove. These grooves correspond, I believe, to the dorsal and ventral surfaces of my organism when exhibiting its spiral twist, for there are really no true lateral grooves, the body being so thin. He made out nothing of the nuclear apparatus in his organisms, but from their appearance, and the number and disposition of the comparatively short flagella, he looked upon the creatures as probably forming a connecting-link between the Ciliata and Flagellata, as the following quotation shows:—"Ich halte es für sehr wahrscheinlich, dass diese vielgeisseligen Flagellaten einen Übergang zu den Ciliaten bilden und möchte speciell die Aufmerksamkeit auf diese noch so wenig bekannten Formen lenken."

From the appearance and structure of the nucleus, I think it is best to include *Spironema* in the Flagellata, though there is something to be said for Klebs's suggestion of it being a connecting-link between the Ciliata and Flagellata. The posterior position of the contractile vacuole is a ciliate characteristic, whilst the organellæ at the anterior end might equally be regarded as long cilia or short flagella. The forms which Klebs examined were obtained from ditch-water, so that there is nothing very remarkable in my obtaining the same organism in cultures of soil.

B. RHIZOPODA.

Each of the soils yielded small amœbæ of the *limax* type, and I have been fortunate in obtaining a number of stages in the division of one or two of the forms.

(1) *AMŒBA LAWESIANA*, sp. n. (Pls. III., IV., figs. 49-65.)

I propose this name* for a small amœba which occurred in a culture of Broadbalk 1865 soil. I put up the culture in the hope of obtaining another kind of protozoon, but instead of getting this particular organism, I obtained an almost pure culture of the amœba in question. Unfortunately, I was unable to devote much attention at the time to observing the living organisms, and for this reason I am not able to state definitely whether a contractile vacuole is present or not. The conditions prevailing at the surface of the culture were very favourable to active life, for my permanent preparations show that the amœbæ were ingesting large numbers of bacteria and dividing forms are fairly abundant.

I have been fortunate in obtaining an almost complete series of dividing organisms, and from the appearance presented by the nucleus during these phases there can be no doubt that this amœba is very closely related to *Amœba glebæ*, which Dobell ('14) has recently described in great detail. It is also similar in its nuclear changes to *Amœba lamellipodia* (Gläser, '12), and the large amœba from liver-abscesses, described by Liston and Martin ('11), and also to *Amœba cucumis* and *Amœba gobanniensis* (Martin & Lewin, '14).

Nevertheless, it differs from all these in certain important details, which are dealt with later on, and for this reason I propose to create a fresh species for its reception.

It is rather smaller than *Amœba glebæ*, and the following are some of its principal measurements:—

Diameter of rounded forms	12-15 μ .
Diameter of nucleus	4- 5 μ .
Diameter of karyosome	2 μ .
Diameter of ripe cysts	10-11 μ .

(a) *Structure.*

When in motion, the body becomes extended in the typical *limax* shape and presents a blunt advancing pseudopodium. The protoplast is composed of an almost hyaline ectoplasm and a much vacuolated endoplasm. In fig. 49 the alveoli of the endoplasm are very irregular in shape and distribution, but in the almost spherical forms assumed during nuclear division the alveoli are fairly regularly distributed throughout the endoplasm and are more equal in size. The body is often crowded with ingested

* I have named this amœba after Sir John Lawes, the founder of the Rothamsted Experiments.

bacteria, and in those forms exhibiting the slug-like appearance the posterior end is frequently covered by an adherent mass of bacteria (fig. 49).

The nucleus consists of a large karyosome, which is separated from the nuclear membrane by a clear zone and an outer ring of faintly staining granules. The latter may apparently occur as very small discrete particles, as in fig. 49, or as a single ring of small blocks, as in fig. 50. I have not succeeded in making out any connecting strands between the karyosome and the nuclear membrane. It resembles the nuclei of *Amœba glebae* and *Amœba lamellipodia* in possessing the ring of faintly staining granules.

(b) *Reproduction.*

The animal ceases to wander about and comes to rest, at the same time becoming spherical. I have not made out pseudopodia in any of these globular dividing forms. The earliest stage in the division of the nucleus which I have discovered is shown in fig. 50, where the karyosome has broken down into four principal masses. This fragmentation of the karyosome is continued until the central part of the nucleus originally occupied by the karyosome, or an area slightly larger than this, becomes filled with a mass which appears to be made up of very faintly staining particles, amongst which are lodged the rather more deeply staining granules produced by the disintegration of the karyosome. I cannot say whether the ring of faintly staining granules occurring in the "resting" nucleus takes any part in the division or whether they disappear. Dobell says that in *Amœba glebae* they entirely disappear, and it may be the same in my organism. The fine particles produced by the fragmentation of the karyosome stain much less intensely than the original karyosome. They gradually aggregate and produce somewhat larger granules, which become connected up into a sort of chain formation, which lies in an irregular manner among the mass of linin particles. The nuclear membrane does not disappear, and does not seem to become any less distinct than during the "resting" condition of the nucleus.

The chain of chromatin granules or chromosomes, as they may perhaps be called, approaches the equatorial region of the nucleus, where it ultimately becomes disposed in the form of a ring (fig. 53). At this stage the first indications of a spindle make their appearance, becoming elaborated out of the linin matrix in which the ring of chromatin granules has been lying. The ends of the spindle are at first broad and rather flattened, but later on they become very sharply pointed. The plane in which the long axis of the spindle lies is slightly oblique to the horizontal plane of the nucleus. This is well seen in fig. 54, where the two ends of the spindle extend beyond the limits of the nuclear membrane which is represented in optical section, one end being over and the other under the nuclear membrane.

In the equatorial ring of chromatin granules I have not been able to distinguish at all clearly the separate constituent chromosomes. This may be due to the fact that they become very closely packed together. They are most distinctly seen in figs. 53 & 54. The equatorial ring becomes divided into two in the plane at right angles to the axis of the spindle. I have not discovered any organism showing the actual constriction of the chromosomes, but have obtained a stage where the two daughter-rings are very closely apposed (fig. 56). In the succeeding stages of division the two rings of chromatin gradually become separated from each other by a wider interval, owing to the elongation of the spindle, the fibres of which become quite distinct across the centre of the animal.

The poles of the spindle remain sharply pointed until a late stage in the separation of the new chromatin bands (figs. 59 & 60).

After the stage which is depicted in fig. 55, the word "band" more accurately describes the appearance presented by the daughter chromatin elements, for I have not been able to make out any ring-like structure after carefully focussing on these parts. Neither have I been able to distinguish separate chromosomes, for each band appears to be composed of numerous fine granules. The nuclear membrane appears to remain intact up to the stage shown in fig. 56, after which, however, it is not distinguishable, and I suppose it disappears entirely.

The animal now elongates in the direction of the long axis of the spindle and becomes ellipsoidal in outline (fig. 59). This figure shows an interesting condition of the spindle-fibres between the chromatin bands, in that a twist in them seems to have been produced as though one of the bands had rotated through an angle of 180° . A constriction now appears round the animal, and the first stage in the process of fission is brought about. Fig. 60 represents this stage, and it is easily seen that the poles of the spindle are sharply pointed at this time.

The process of the re-formation of the daughter-nuclei now begins. The pointed poles of the spindle disappear, and the chromatin granules become scattered irregularly in a mass of faintly staining linin particles which are apparently formed by the break-up of the outer portion of the spindle-fibres. In fig. 61 one daughter-nucleus is seen to consist of a crescentic area of linin particles in which the small granules of chromatin are scattered, whilst at the other end of the spindle the daughter-nucleus consists of a small though well-developed central granule, no doubt formed by a fusion of smaller granules, surrounded by a ring of linin particles, from which it is separated by a clear zone. I think there can be no doubt that the crescentic daughter-nucleus represents an earlier stage in the process of reorganisation than the round form in the other part of the constricted amoeba.

In fig. 62 the constriction of the parent amoeba has been carried a little further, and the spindle-fibres between the

re-forming nuclei could be made out on focussing very carefully. It can be seen from this figure that the reorganisation process takes place earlier on the outer side of each nucleus than on the inner side. I have not been able to distinguish any reticulate arrangement in the linin particles which are laid down as the process of reorganisation commences. The fission of the body is now carried a little further, and the two daughter-organisms are produced. There does not appear to be any connecting strand of protoplasm between the two products of fission, though in all these stages this region is extremely difficult to make out, owing to the presence of large masses of adherent bacteria, which I have purposely omitted from the drawings.

The new karyosome now increases in size by the absorption of the remaining fine granules of chromatin. It is no longer possible to distinguish any spindle-fibres, and each nucleus becomes rounded off. The new nuclear membrane is apparently formed from the zone of linin surrounding the new karyosomes, and from this zone also the peripheral ring of feebly staining granules is also produced. The only difference between the nucleus of the stage represented in fig. 63 and that of a full-grown animal is merely one of size.

(c) *Encystation.*

On the same preparations which showed dividing animals, I obtained a few stages revealing the process of encystation. The first indication of this is the production of intensely staining small round granules in the endoplasm, as shown in fig. 64. In this animal I could discover very few ingested bacteria, and it is evident that the normal process of digestion becomes suspended with the beginning of encystation. There is practically no difference in the appearance of the nucleus during the process of encystation, and even when the cyst-membrane has become well defined, as in fig. 65, it was still possible to distinguish all the principal structures of the nucleus. The karyosome in the encysting animals is rather smaller than in normal active forms. As encystation proceeds, there is a gradual contraction of the endoplasm round the nucleus, so that the ectoplasm is left as a distinct region free from granules. This is particularly well shown in fig. 64, where the line of separation between the two constituents of the protoplast is especially marked. The animal diminishes somewhat in bulk, and the cyst-membrane is laid down around it. This later on becomes much corrugated and indented, as shown in fig. 65. It is quite well defined at this stage, but becomes somewhat thicker at a later period; a point which I have determined by the examination of empty cysts. There does not appear to be an endocyst. In possessing deeply stainable granules, the cysts differ from those of *Amœba glebae*, in which Dobell describes non-stainable extremely refractile granules. I do not know what the real nature of the granules

produced in the endoplasm is, but they are of fairly common occurrence in the cysts of other forms of *limax* amœbæ. At all events they are not particles of chromatin extruded from the karyosome, for this does not diminish in bulk to any great extent, and, moreover, there is a sufficient volume of granular material produced in the endoplasm to make several karyosomes if it were fused together. Probably they are of a reserve food character. I cannot, however, throw any light on their presence or absence in newly excysted organisms, for I did not make any observations on the excystation of this amœba.

(d) *Remarks.*

Dobell has gone very thoroughly into the differences and similarities between his *Amœba glebæ* and its nearly related forms, so that it is quite unnecessary for me to go into this question in detail. I will merely point out, therefore, in what respects my organism differs from or resembles *Amœba glebæ*.

It is obvious, from a comparison of the figures illustrating this account and that of Dobell, that the amœbæ to which they refer are very closely related in their method of nuclear division. The type of division is the same in each, and it is merely in details that differences are presented. The most important are the following:—

1. *Amœba lawesiana* is a somewhat smaller organism than *Amœba glebæ*.
2. The nuclear membrane persists to a much later stage of division in *Amœba lawesiana* than in *Amœba glebæ*.
3. The spindle formed in the division of the nucleus is sharply pointed at each end in *Amœba lawesiana* and is rounded or barrel-shaped in *Amœba glebæ*.
4. The resting-cyst of *Amœba lawesiana* is irregular in outline, whereas that of *Amœba glebæ* is perfectly round and has a smooth outer wall.
5. Within the endoplasm of the cyst of *Amœba lawesiana* large numbers of deeply staining granules are produced, whereas in the cyst of *Amœba glebæ* highly refractive granules occur.

(2) *AMŒBA AGRICOLA*, sp. n. (Pl. IV. figs. 66–74.)

I propose to describe under this specific name a small amœba which occurred in one of the cultures made from Hoosfield 1868 soil. It exhibits some rather remarkable appearances during the division of the nucleus, which seem to differ from any of the already described nuclear divisions in amœbæ; and it is on the strength of this fact that I propose the creation of a new species for its reception. I made no special observations on the live animals, so that, in this respect, what I have to say about them is, unfortunately, incomplete. My notes merely record the presence of numerous *limax* amœbæ in this particular culture.

I made one or two film preparations, which, after fixation and staining, showed the presence of large numbers of amœbæ, together with the flagellate *Cercomonas longicauda*. In going carefully over one of these preparations, I discovered a number of interesting stages of dividing nuclei; and though I have not obtained a very complete series of these, I have made out sufficient to show that I am dealing with an organism hitherto undescribed.

(a) *Structure.*

There is nothing remarkable in the appearance of the ordinary individuals. The body presents an endless variety of shapes, and the pseudopodia are very irregular and lobose, whilst the distinction between ectoplasm and endoplasm is not at all clear. So far as I can ascertain, the endoplasm is not alveolate in structure. At any rate, if alveoli are present they are not large and distinct like those in *Amœba lawesiana* and *Amœba glebæ*, for in only one of the animals could I make out anything at all approaching alveoli. I do not wish to emphasize this point, however, for the preparation was slightly over-differentiated and the cytoplasm in all the amœbæ was only very faintly stained. On the whole, the endoplasm appears very finely granular in structure, with somewhat denser masses scattered about in it; and the figures which illustrate this account represent it fairly accurately.

The resting nucleus consists of a central deeply staining karyosome, separated by a clear zone from the nuclear membrane, with which it appears to be connected by very feebly staining strands stretching across the zone at various points. I have not been able to make out the presence of a ring of granules just within the nuclear membrane as in *Amœba lawesiana*. The principal measurements are as follows:—

Length of body 12–15 μ , though this measurement is not of much value because of the very irregular shape of the organism.

Diameter of nucleus, 2.75–3 μ .

Diameter of karyosome, 1.8–2 μ .

It is thus rather smaller than *Amœba lawesiana*.

(b) *Reproduction.*

The body does not become globular during nuclear division as in *Amœba glebæ* and *Amœba lawesiana*, but retains its very irregular appearance. The karyosome in the earliest stages of division loses its rounded shape and increases in size. At the same time it begins to break up into a number of ill-defined granules, which appear to rest on a matrix which stains only feebly. I have only encountered a few of these early stages, and therefore cannot give much information concerning the changes which go on at this period.

The final result of the break-up of the karyosome is the

formation of irregular chromosomes, some of which appear rod-like and others rather rounded. While these changes are taking place the whole nucleus increases in size and becomes barrel-shaped, attaining a length of 6-7 μ . A few spindle-fibres make their appearance within the nucleus, but no definite spindle comparable with that found in *Amœba lawesiana* is produced. Moreover, the fibres seem to lie on the nuclear membrane rather than within the cavity of the nucleus. The chromosomes now become arranged on the fibres, but I have not discovered any examples which show all the chromosomes arranged in an equatorial ring or band. All the stages of this phase of division show two principal groups of chromatin granules or chromosomes at each end of the long axis and other chromosomes irregularly disposed in the equatorial region. In the latter region the individual chromosomes are extremely difficult to distinguish, and it is therefore practically impossible to count them. There appear, however, to be about eight chromosomes or chromatin masses produced within each nucleus, four of which travel to each end. A description of these stages of division is very difficult to make owing to the fact that no two stages exactly agree, as will be seen on referring to figs. 68-70. All of them are, however, of the same general type, and a detailed description of each is unnecessary. The chromosomes ultimately become drawn to the two poles of the nucleus, a stage which is well shown in fig. 71.

Shortly after this, or even earlier, the chromosomes begin to break up and lose their distinct outline. As a result of this, a granular mass of chromatin, rather triangular in outline, is produced at each end of the nucleus (figs. 72 & 73). The nucleus now begins to elongate, and the chromatin is reorganised into daughter-nuclei, which thus gradually separate further and further apart. In fig. 73 a stage is shown in which a dumb-bell appearance is presented by the two rounded daughter-nuclei and the nuclear membrane constricted between them. This is the latest stage of division that I have obtained. I have failed to discover any stages showing fission of the animal, and it seems to be fairly evident that this occurs after nuclear division is quite complete. In this connection it is interesting to note that I have found a large number of bi-nucleate amœbæ on the same preparation. It is possible that these are forms in which fission is retarded, or again they may be abnormal individuals, for I have found one or two tri-nucleate forms as well.

(c) *Remarks.*

The nuclear division in *Amœba agricola* differs from that which occurs in any other amœba. It is obviously a modified mitosis, but it is not easy to connect it up with any of the numerous mitotic nuclear divisions which have been described and figured in other amœbæ.

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EXPLANATION OF THE PLATES.

All the figures are camera lucida drawings, and were made with the aid of Zeiss 2 mm. apochromatic objective and compensating oculars 18 and 12, giving approximate magnifications of 2786 and 1833 diameters respectively.

PLATE I.

All figures magnified 2786 diameters approximately.

Prowazekia (Bodo) saltans.

- Fig. 1. Organism seen from the ventral aspect.
 2. Side view.
 3. Dorsal view, a small blepharoplast at the base of each flagellum.
 4. Doubling of the anterior flagellum.

- Figs. 5-8. Early stages in nuclear division.
 9-12. Four small chromosomes present in the nucleus.
 13-16. Fragmentation of chromosomes and division of the nucleus.
 17-20. Elongation and division of kinetonucleus and constriction of the body into two daughter-organisms. The new trophonuclei are unrecognisable in these stages.
 Fig. 21. Two daughter-organisms nearly separated; new trophonuclei visible.
 22. Small recently separated daughter-form.

PLATE II.

Owing to the exigencies of space in making up the Plate, the full extent of the two pairs of flagella is shown only in figs. 23 & 26.

Tetramitus spiralis, sp. n. All figures $\times 2786$.

- Figs. 23 & 24. Two normal forms, showing the groove.
 25 & 26. Showing the relations of flagella, blepharoplasts, rhizoplasts, and nucleus.
 Fig. 27. Showing new flagella arising from anteriorly enlarged blepharoplasts.
 28. The flagella have migrated before the nucleus shows signs of division.
 Figs. 29-33. Successive stages in early phases of nuclear division.
 34-36. Stages showing four principal chromatin masses within the dividing nucleus.
 37-41. Later stages in nuclear division.

PLATE III.

Figs. 42-45. *Tetramitus spiralis*, sp. n. $\times 2786$.

- Figs. 42-44. Later stages of division, showing the formation of daughter-organisms.
 In fig. 43 there appears to be a production of large vacuoles on the longitudinal axis of the body.
 Fig. 45. The two new organisms have just separated.

Figs. 46-48. *Spironema multiciliatum*. $\times 1833$.

- Fig. 46. A rather small form having 8 flagella and showing the contractile vacuole at the beginning of the tail. The extra-karyosomic part of the nucleus has very small granules on its outer edge.
 47. A longer form showing 18 flagella, rather irregularly disposed.
 48. A long form showing spiral twist of the anterior part of the body and contractile vacuole towards posterior end.

Figs. 49-55. *Amœba lawesiana*, sp. n. $\times 1833$.

- Fig. 49. Normal individual of typical *limax* form, showing feebly staining granules just inside the nuclear membrane, and a mass of adherent bacteria² at posterior end.
 Figs. 50-52. Early stages in nuclear division showing disintegration of the karyosome and the production of a chain of chromatin granules or chromosomes.
 Fig. 53. The formation of the spindle at first, having broad ends extending beyond the nuclear membrane. The chromosomes are arranged in an equatorial band.
 Figs. 54 & 55. The spindle has become pointed at each pole and is placed obliquely to the horizontal plane; ring of chromosomes.

PLATE IV.

Figs. 56-65. *Amœba lawesiana*. $\times 1833$.

- Fig. 56. Equatorial ring just divided.
 Figs. 57 & 58. Elongation of the spindle and separation of the new chromatin bands.
 Fig. 59. Late stage of nuclear division, showing a twisting of the central portion of the spindle.
 60. Commencement of constriction of the organism.

Figs. 61-63. Completion of fission and reorganisation of the daughter-nuclei.
64 & 65. Stages in encystation showing the production of deeply staining granules within the endoplasm. In fig. 64 the endoplasm appears sharply separated from the ectoplasm.

Figs. 66-74. *Amæba agricola*, sp. n. $\times 2786$.

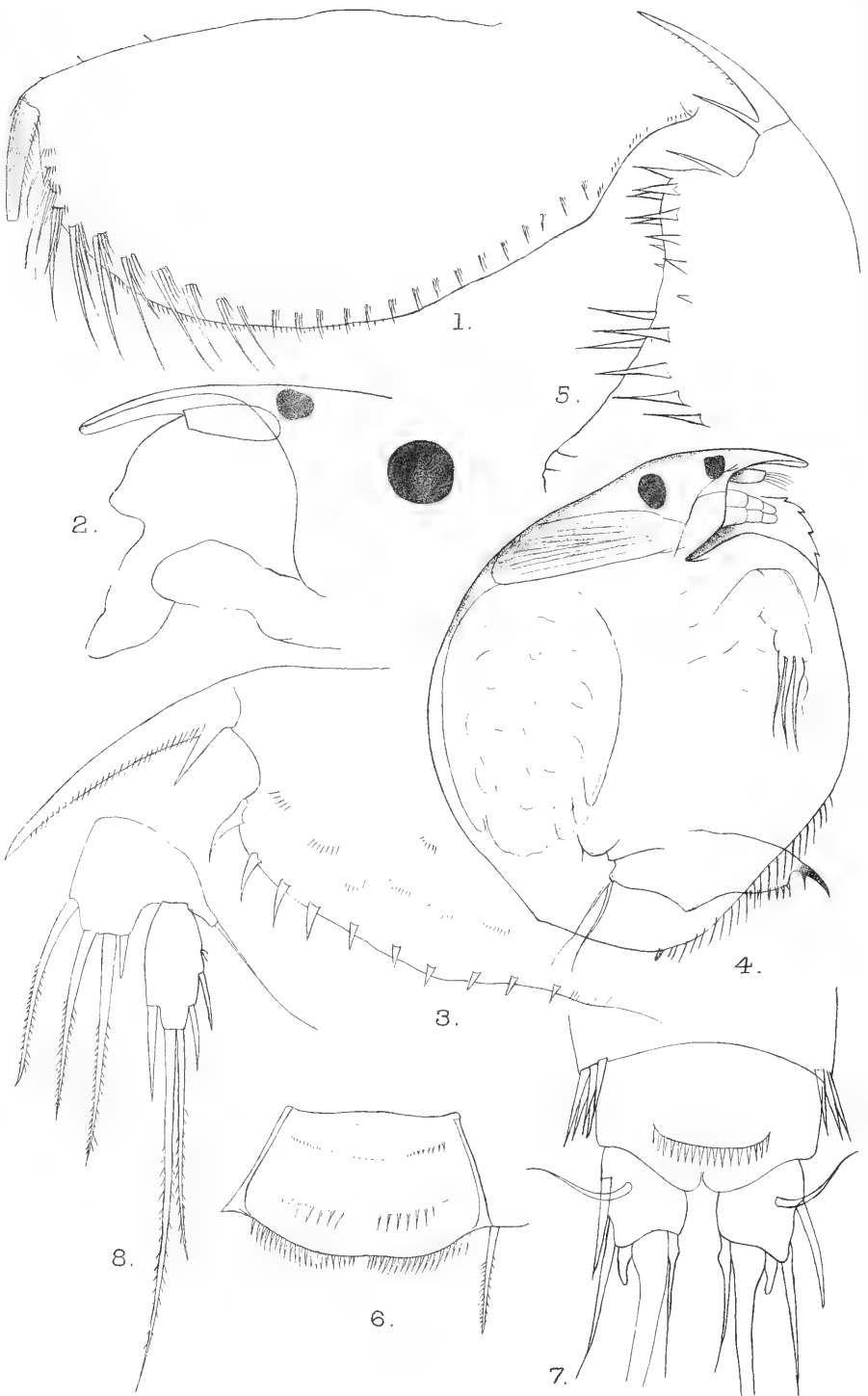
Fig. 66. Normal form.

67. Granulation of the karyosome.

Figs. 68-70. Showing a variety of stages in the arrangement of the chromosomes on the nuclear spindle. In each case there appear to be two principal chromosomes at each pole and variously situated chromosomes in the equatorial region.

Fig. 71. The chromosomes are drawn to each pole.

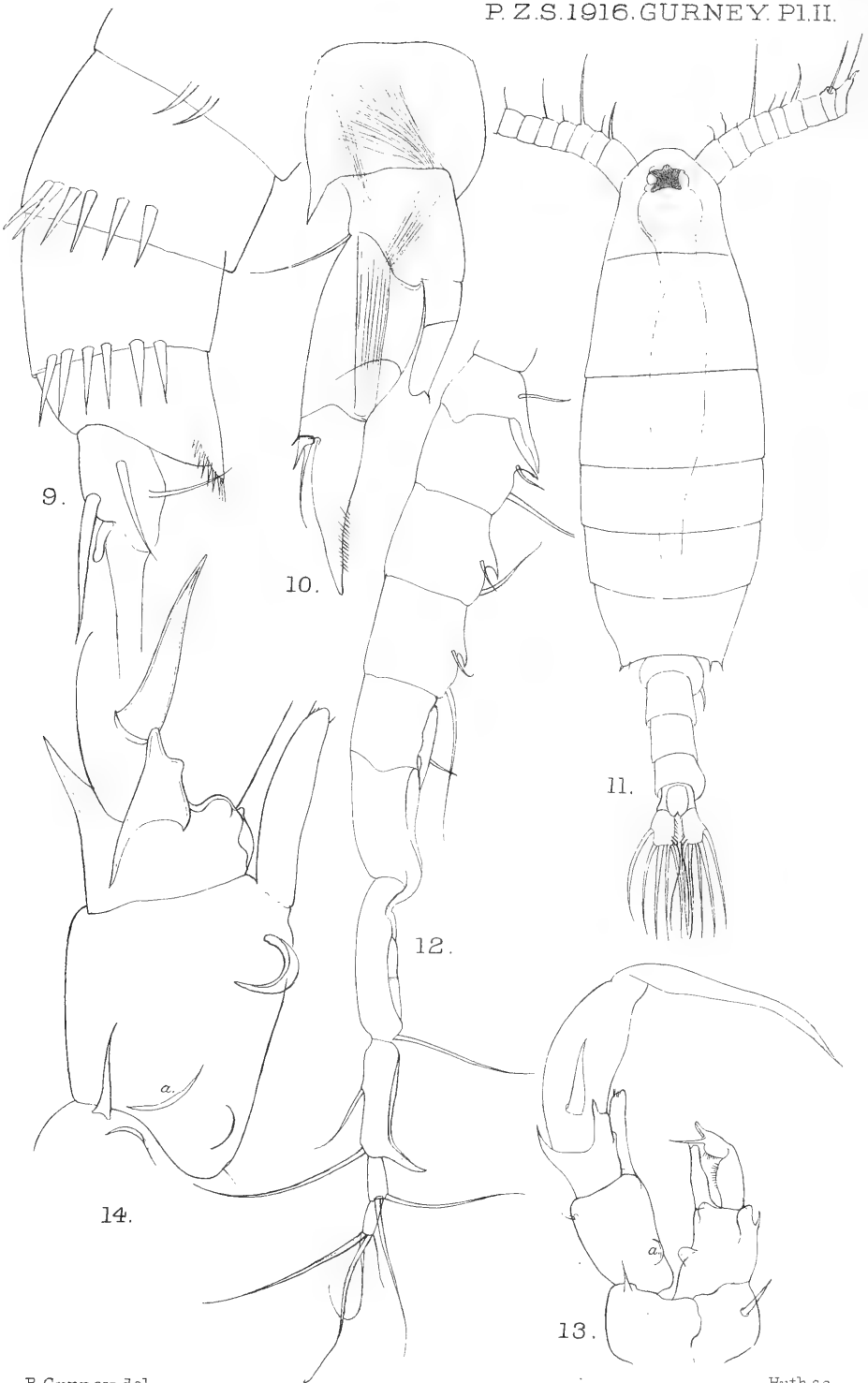
Figs. 72-74. Granulation of chromosomes and formation of daughter-nuclei.

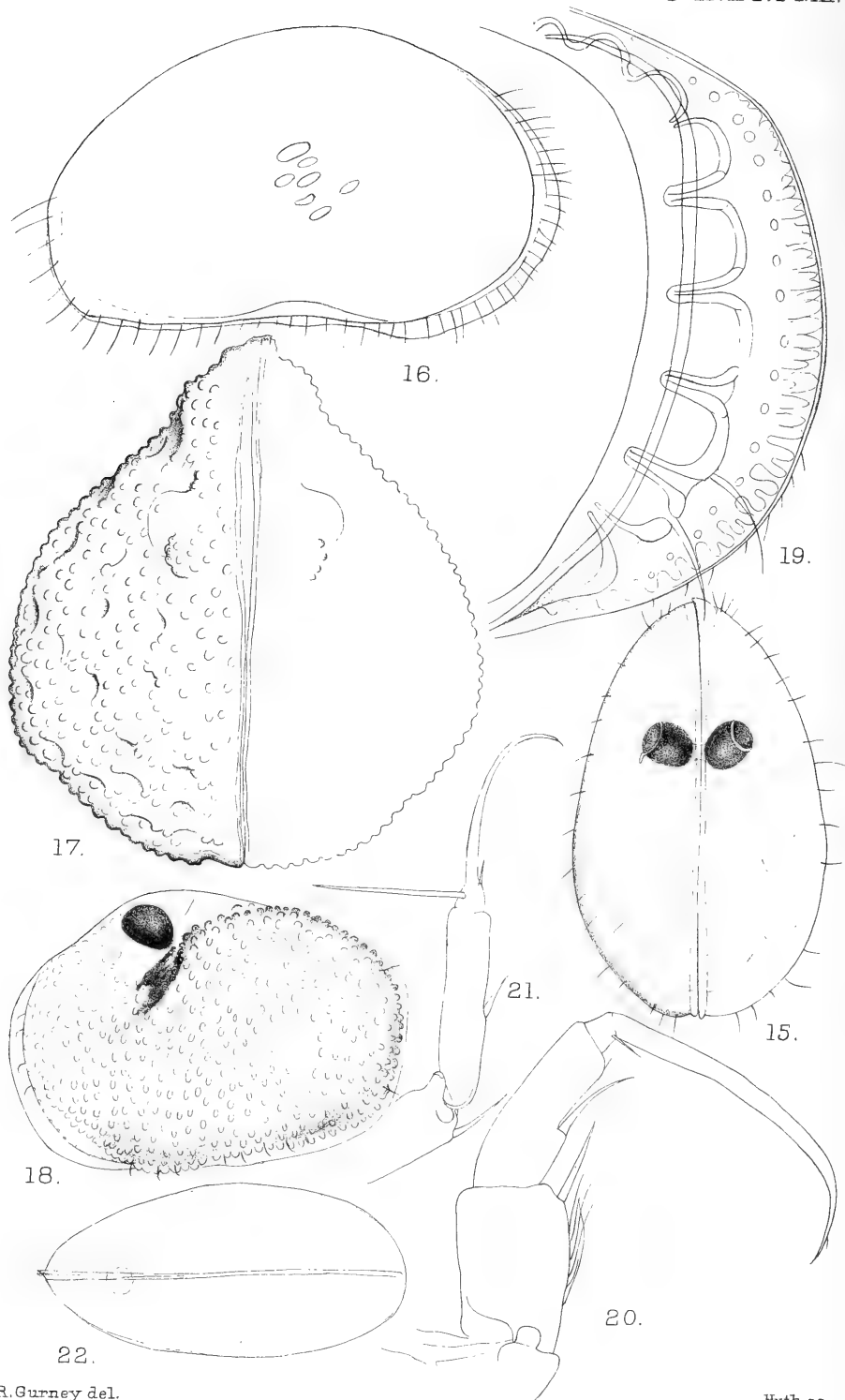


R. Gurney del.

Huth sc.

ENTOMOSTRACA FROM CEYLON.





R. Gurney del.

Huth sc.

ENTOMOSTRACA FROM CEYLON.

9. On some Fresh-water Entomostraca from Ceylon.

By ROBERT GURNEY, M.A., F.Z.S.

[Received February 8, 1916 : Read April 4, 1916.]

(Plates I.-III.* and Text-figure 1.)

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The fresh-water Entomostraca of which an account is given here were collected by Mr. G. W. Smith during a visit to Ceylon in September and October, 1907, on his return from Tasmania, and I desire to express my thanks to him for his kindness in handing them over to me for examination. The collections were made in various waters at Colombo, Kandy, Peradeniya, Mahintele, and Anuradhpura, but I have not thought it necessary in most cases to specify precisely in what spot a particular species was found.

The most complete account that has been published of the Entomostraca of Ceylon is that given by Daday in 1898; but there have been several other contributions made to our knowledge of them, so that we now know of 94 species or well-marked varieties inhabiting Ceylon. Mr. Smith's collections contain 35 species, of which three are, as I believe, hitherto undescribed, and several are additions to the list. It is rather remarkable that, of the four species of *Diaptomus* here recorded, three have not before been taken in Ceylon, and it is quite evident that the fresh-water Entomostraca of Ceylon are very far from being completely known.

I. PHYLLOPODA.

CYCLESTHERIA HISLOPI Baird.

Nine specimens, some with developing young in the brood-pouch, were taken in the Colombo water-supply.

II. CLADOCERA.

DIAPHANOSOMA EXCISUM Sars.

A considerable number of specimens of a species of *Diaphanosoma* were found in a tank at Kandy by Lady Horton's Drive and also in Colombo Lake, while a few were taken at Anuradhpura.

* For explanation of the Plates see p. 343.

All belong to the same species, and that, in my opinion, is *D. exisum*, since they agree in all essential respects with Sars's description, though somewhat smaller than the size given by him. It is remarkable that the only species of *Diaphanosoma* recorded from Ceylon is *D. singalensis* Daday, which was found by Apstein to be common in the Colombo Lake from January to September. All the specimens that I have examined have the ventral shell-margin markedly reflexed, and cannot possibly be referred to *D. singalensis*. It is possible that there is a seasonal alternation of the two forms.

DAPHNIA LUMHOLTZI Sars.

A few young specimens were taken in a tank at Kandy.

CERIODAPHNIA RIGAUDI Richard.

Peradeniya pond; Colombo Lake; Mahintele; Anuradhpura; Kandy tank.

CERIODAPHNIA CORNUTA Sars.

Kandy, in a pond by Lady Horton's Drive and in the tank.

Daday (1898) has expressed, and still maintains, the opinion that *C. cornuta* and *C. rigaudi* are merely extreme forms of one species, and a careful examination of the specimens at my disposal gives much support to such a view. The presence or absence of a head-spine is, in my specimens, usually correlated with the possession of a posterior shell-spine, which is slightly bifurcated or simple respectively; but not only do both *rigaudi* and *cornuta* forms occur together in the same collections, but also individuals are found which it is almost impossible to assign to one or the other. The head-spine may be so small as to be detected with great difficulty, and the shell-spine may show but the faintest trace of bifurcation. It appears to me that the *rigaudi* form may occur alone, but that wherever (in Ceylon) *C. cornuta* occurs, there also are found a small number of individuals which, in the lack of its distinctive characters, approach *C. rigaudi*. One may conclude that the species may be in fact distinct, but that *C. cornuta* is very variable and may approach *C. rigaudi* in appearance. The *cornuta* form described by Stingelin from Java, and having a double head-spine, must be regarded as merely a variety of the species, since Daday (1910) has found specimens with double head-spines together with others of the typical form in Victoria Nyanza.

MOINA DUBIA Richard.

Kandy; Mahintele; Anuradhpura. Common.

I take this opportunity of correcting an error in my figure of this species recently published (1911, pl. ii. fig. 1). In this figure the reticulations of the ephippium are shown strongly marked over the egg-space, whereas, though a very faint reticulation can sometimes be detected, the egg-space usually appears quite

unmarked. These faint markings were shown in my drawing and have become accentuated in the plate.

MACROTHRIX ODIOSA Gurney.

Peradeniya pond. Abundant in a plankton collection taken at night, but much less common in plankton and in weeds during the day. Also taken at Anuradhpura.

The species bears some resemblance to *M. singalensis*, but differs from it in the form of the upper lip, the arrangement of cilia, and teeth on the antenna and on the post-abdomen. While the adult differs considerably from *M. triserialis* in the shape of the valves, the young closely resemble it, being of a pointed pear-shaped form.

MACROTHRIX TRISERIALIS Brady.

Mahintele—Snake's pool. Two specimens only seen.

LEYDIGIA AUSTRALIS Sars.

In a tank at Anuradhpura great numbers of cast shells of a species of *Leydigia* were taken, and among these there are two or three post-abdomina, but none with the terminal claw attached. However, the shape of the post-abdomen and the arrangement of the spines, together with the fact that the shell-valves are not striated, make it certain that the species is *L. australis*. The arrangement of the spines is distinctive in this species; there is a regular series, decreasing in size anteriorly, of groups containing one long spine and two very short ones, and these groups are not replaced by groups of cilia till the anal depression is reached.

At Mahintele a single specimen of a *Leydigia* was taken which agrees most closely with *L. australis* var. *ceylonica* Daday. In this specimen the spines of the post-abdomen are more slender and partly arranged in fours (Pl. I. fig. 1), and the shape of the post-abdomen recalls that of *L. propinqua*. My specimen, which is much decayed, differs from Daday's form in absence of sculpture on the shell.

ALONA RECTANGULA Sars.

A few specimens of a small form of this species were taken in Peradeniya pond. Some females are ehippial, but no males were seen. In some specimens the upper lip has a minute tooth on its anterior margin.

ALONA INTERMEDIA Sars.

Old tank at Anuradhpura.

ALONELLA DAVIDI Richard.

One specimen and a moulted shell were included in a collection from the old tank at Anuradhpura. They agree exactly with regard to form of post-abdomen and arrangement of spines and

cilia with the specimens described by Stingelin (1904) from Java and Honolulu, except that here the claws have no cilia. But in my specimens the shell is distinctly striated, but without reticulations, thus approaching more nearly to Richard's description.

I have already (1911) given reasons for regarding *A. davidi* and *A. punctata* Daday as varieties of *A. diaphana* King, but I am inclined to think that, though I still believe the three species to form a gradational series, yet it is perhaps more convenient and less cumbersome to leave the three names to define the three varieties.

ALONELLA KARUA King.

Peradeniya and Anuradhpura.

ALONELLA EXCISA Fischer.

Peradeniya pond.

CHYDORUS PARVUS Daday. (Pl. I. figs. 2, 3.)

Peradeniya pond and Priest's Well; Kandy; Anuradhpura.

In 1898 Daday described, under the name of *C. sphaericus* var. *parvus*, a *Chydorus* from Colombo Lake, differing chiefly from *C. sphaericus* in the form of the upper lip (fig. 2), and I have little hesitation in referring to this species a *Chydorus* which is common in some of Mr. Smith's collections. These specimens, which vary from .28 to .35 mm. in length, are nearly globular in shape and usually of an opaque golden-yellow colour. In the form of the upper lip and of the post-abdomen (fig. 3) they agree very closely with Daday's description, but they differ in the fact that I have been unable to detect with certainty any sculpture on the shell, whereas Daday's species shows strong reticulation.

CHYDORUS BARROISI Richard. (Pl. I. figs. 4, 5.)

Peradeniya pond; Anuradhpura.

My specimens unite in a very perplexing way the characters of *C. barroisi* and *C. poppei* Richard. All my specimens agree in having the upper lip strongly serrated and in the arrangement of spines on the post-abdomen (fig. 5), and nearly all have the shell-valves smooth. The majority have also a tooth at the posterior ventral angle of the shell (fig. 4) and an additional minute spine at the base of the caudal claws, but I have also seen specimens which lack the one or the other. In the structure of the post-abdomen they agree much more closely with *C. poppei* than with *C. barroisi*. *C. hybridus* Daday unites in the same way the characters of the two species, and it seems to me that the three are not, in fact, specifically distinguishable. *C. poppei* has been recorded only from South America and from the Southern United States, but *C. barroisi* occurs in Syria, Ceylon, various parts of Malaysia, New Zealand, East Africa, and South America. Stingelin (1913) also expresses the opinion that the three above-named species should probably be united into one.

III. COPEPODA.

CYCLOPS DISTINCTUS Richard. (Pl. I. fig. 6.).

In a collection from a pond by Lady Horton's Drive at Kandy a few specimens of a *Cyclops* were found, which I assign with some hesitation to this species. The specimens included only a single adult female, the rest being chiefly adult males.

My specimens differ in some important respects from typical European specimens with which I have compared them:—

- (1) In size. Length: ♀, 1.44 mm.; ♂, .95 mm. Whereas English specimens measure about 2 mm. (♀).
- (2) Furcal rami. Whereas in typical *C. distinctus* the rami are about $2\frac{1}{2}$ times longer than they are broad, in specimens from Kandy they are less than twice the breadth. Also in the latter the lateral seta is very long—longer than the ramus. The proportional length of the remaining setae is the same in both.

Since in other respects—as, for example, in the form of the fourth pair of legs and their uniting lamella (fig. 6)—the agreement is complete, I do not think the differences are sufficient to constitute a distinct species.

CYCLOPS NYALINUS Rehberg.

Kandy; Mahintele; Anuradhpura.

CYCLOPS LEUCKARTI Claus.

Peradeniya; Kandy; Anuradhpura.

CYCLOPS VARICANS Sars.

Peradeniya; Kandy; Anuradhpura. Rare.

CYCLOPS VARIUS Lillj., var. *PROXIMUS* Lillj.

A few specimens taken in the Priest's Well at Peradeniya.

CYCLOPS PRASINUS Fischer.

Peradeniya—Priest's Well; Kandy—Lady Horton's Drive pond.

CANTHOCAMPTUS GRANDIDIERI Guerne & Richard, var. (Pls. I. & II. figs. 7-9.)

In collections from Peradeniya and from Anuradhpura a few specimens of a species of *Canthocamptus* were found which I find difficulty in identifying. In most respects they agree very closely with descriptions given of *C. grandidieri*, but with regard to the furca and to certain details of the fifth pair of legs there are differences which are constant and considerable. The furcal rami are more or less quadrangular, bearing at their apex a short slender seta on the inner angle and a single very long seta with

a rather swollen base (fig. 7); but in place of the usual external long seta there is, in all adults, merely a small finger-like outgrowth. On the other hand, in all immature specimens two setae are present of the usual form. A further difference is that the ramus is not, as is usual in *C. grandidieri*, distinctly produced dorsally. There is indeed a slight overhang, but it is scarcely noticeable (fig. 9). With regard to the fifth pair of legs the agreement is closer, but here the innermost spine of the basal joint is very much shorter than the others, and the second joint is smooth on its inner face (fig. 8). In the proportional length of the spines on this leg my specimens agree more nearly with *C. laciniatus* Van Douwe, which itself seems to me only a variety of *C. grandidieri*. Brady's description of *C. cingalensis* is too incomplete to make any satisfactory comparison possible.

DIAPTOMUS DORIAI Richard.

Anuradhpura. Rare.

DIAPTOMUS STRIGILIPES Gurney.

Anuradhpura—Baltring tank; Mahintele. Abundant.

DIAPTOMUS ANNÆ Apstein. (Pl. II. fig. 10.)

Peradeniya pond; Kandy; Colombo Lake.

Brehm has found that specimens from Kandy do not agree in all respects with the description given by Apstein, the third joint of the exopodite of the fifth foot in the female being clearly distinct, and argues that the separation or fusion of this joint is therefore not of great systematic importance. In all my specimens this joint is separate, and Apstein has found that it is, in fact, distinct in his original specimens. The endopodite of this leg in my specimens, as in Brehm's, is considerably shorter than the first joint of the exopodite, and, in respect of length, this joint seems to be very variable. I have seen one specimen (fig. 10) in which this branch was clearly two-jointed, but this is evidently an abnormality.

DIAPTOMUS VIDUUS, sp. n. (Pl. II. figs. 11–14.)

In a collection from the Snake's pool at Mahintele, among large numbers of *D. strigilipes*, a single male *Diaptomus* was found which appears to belong to an undescribed species. In spite of very careful search I have found only the single specimen, but it seems to me so distinct that it is best to describe and name it.

The body is slender and tapering anteriorly; last segment of the thorax with pronounced posterior angles bearing two small spines on either side (fig. 11). Fourth abdominal segment asymmetrical, being slightly swollen on the right side. Furcal rami and setae of normal shape. The left antenna reaches, when reflexed, to the end of the fourth abdominal segment. The

antepenultimate joint of the right antenna has a hyaline membrane and a short outwardly-turned hook (fig. 12). The fifth leg (fig. 13) on the right side has two small hyaline processes on the second basal joint; the endopodite is longer than the first joint of the exopodite. The first joint of the exopodite is produced laterally into a pointed process and bears on its posterior face a large hyaline process (fig. 14). The second joint of the exopodite has the spine, which is usually lateral and distal in position, inserted on the posterior face near the base of the joint.

Length 1.75 mm.

IV. OSTRACODA.

NOTODROMAS OCVLATA Sars. (Pl. III. fig. 15.)

Tank by Lady Horton's Drive.

This species differs very little from *N. entzi* Daday, being somewhat smaller and with different markings. In dorsal view it is seen that *N. entzi* is much wider behind than in front, whereas in *N. oculata* the outline is an almost regular oval (fig. 15).

STRANDESIA (CYPRIS) VITTATA Sars.

Common in Peradeniya pond.

My specimens agree in all respects with Sars's description, with the exception that they do not show the coloured bands mentioned by him, the absence of which is possibly due to the preservative. The curious "lop-sided" appearance in end view is very characteristic. Previously recorded from Puching, China.

EURYCYPRIS SUBGLOBOSA Sowerby.

Colombo Lake. Rare.

STENOCYPRIS MALCOLMONI Brady.

Colombo Lake.

CYPRICERCUS RETICULATUS Daday ?

A considerable number of specimens of a species of *Cypricercus* were taken in Peradeniya pond. Unfortunately all appear to be immature, not exceeding .7 mm. in length and with the ovary barely distinguishable. My specimens differ somewhat from *C. reticulatus* in shape and also in the complete absence of any shell-sculpture, but I cannot assign them to any other species nor safely describe them as new.

CYPRIDOPSIS NEWTONI Brady & Robertson. (Pl. III. fig. 16.)

Syn. *C. aldabrae* Müller.

Great quantities of this species were found in Colombo Lake and a few specimens at Mahintele. Apstein has recorded *Candonella albida* Vavra from Colombo Lake, but I have found no

specimens which can be referred to that species. On the other hand, the shape of the shell (fig. 16) points unmistakably to the closely allied species *C. aldabre*, with which my specimens agree also in other respects. Unfortunately I have not been able to find a single male, so that the comparison is incomplete.

ONCOCYPRIS PUSTULOSA, sp. n. (Pl. III. figs. 17-21.)

Seen from above the animal is pear-shaped, very broad behind and tapering anteriorly, with a constriction in front of the eye (fig. 17). In quite young individuals the shape is that of an egg, with the greatest width just behind the middle and tapering evenly in front and behind. Seen from the side the two valves are alike, kidney-shaped, broader in front than behind (fig. 18). The cuticular border is broad anteriorly, scarcely visible ventrally, and narrow behind. Seen from inside, the structure of the shell is distinctive. In the left valve the anterior cuticular border is very broad and springs from the edge of the shell, its point of origin being marked by the accompanying setæ. Beyond this point is the "pore-canal" zone, in which are seen a series of strongly marked semicircular loops which appear to indicate unbranched pore-canals, but their real nature is not at all clear (fig. 19). Cutting across them is seen a conspicuous ridge. The structure is much the same posteriorly and in the right shell.

The surface of the shell is thickly covered with little knobs, but in very young specimens it is strongly reticulated and pitted. The eyes are very large and united. The general colour, in spirit, is golden yellow with a conspicuous greenish pigment-spot on either side of the eye.

The maxilla has no respiratory plate, but in place of it there is a single small seta. Müller gives the entire absence of setæ as an important character of the genus, and it is possible that the specimen in which I have seen the seta is abnormal in this respect. From the small number of specimens at my disposal I am unable to go further into the matter. In the second maxilla there are two strong spines on the third lobe, one of which is toothed and the other smooth. In the first leg the third and fourth joints are fused; the last joint bears a very large curved spine and a single short seta (fig. 20). The second leg has a well-developed terminal joint bearing a long curved claw, a seta of about the same length, and a small hair (fig. 21). The furca is a simple flagellum.

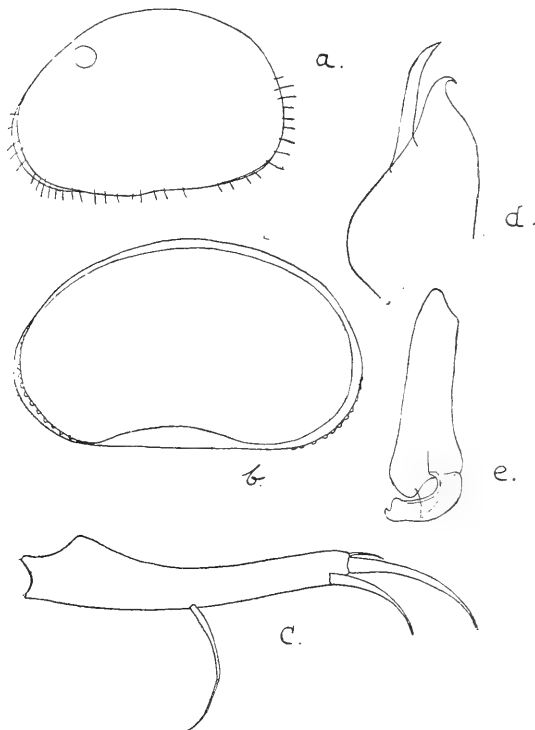
Length .5-.58 mm.; width .43-.54 mm.; height .3-.38 mm.

A very few female specimens of this species were taken in a tank by Lady Horton's Drive at Kandy. The genus *Oncocypris* was established by G. W. Müller for a species, *O. voeltzkowi*, from Madagascar, which has since been found also in Abyssinia (Daday) and South Africa (Brady). The only other species of the genus is *O. costata* Daday from German East Africa. It is therefore of considerable interest to find that a species of this African genus occurs also in Ceylon.

PHYSOCYPRIA TUBERATA, sp. n. (Pl. III. fig. 22; text-fig. 1.)

Female. Seen laterally the shell is oval, the greatest height equal to two-thirds the length and falling behind the middle (text-fig. 1 *a*). The anterior end is much less broad than the posterior end. The right and left shells are of the same shape, the left shell slightly the larger and overlapping the right in front. Both shells have a narrow hyaline border and are fringed

Text-figure 1.

*Physocypria tuberata*.

- a.* Female. Left valve, $\times 66$.
b. Male. Right valve from inside, $\times 126$.
c. Female. Furcal ramus, $\times 274$.
d. Male. Copulatory organ, $\times 274$.
e. „ Clasping organ of right side, $\times 274$.

with long scattered setæ. The right shell differs from the left in having a row of small knobs on the anterior and posterior margins (text-fig. 1 *b*). Seen from above the shell is much compressed and narrower in front than behind (Pl. III. fig. 22). The surface of the shell is smooth, but marked with small brown

spots. In the second leg the penultimate joint is three and a half times as long as the last joint and without cilia. The last joint bears two subequal claws and a recurved seta longer than the last three joints of the leg. The furcal rami are slightly curved and bear two short stout claws and a very short seta at the apex. The dorsal seta is inserted about the middle, and is nearly half as long as the furca and about the same length as the longest claw (text-fig. 1 c). Length .45-.5 mm.; height .27-.28 mm.

Male. The male differs somewhat from the female, the dorsal margin of the shell being more flattened and the two ends more equally rounded. The tubercles of the right shell are conspicuous. The palp of the right second maxilla is slender, broader at the end, and with a triangular pointed process (text-fig. 1 e); the last joint is in the form of a curved blunt-ended claw. The palp of the left side is more or less cylindrical, not dilated at the end, and with a minute tooth in place of the triangular process of the right side. The distal joint forms a curved sharp-pointed claw. The copulatory apparatus consists of a large triangular lamella with pointed recurved end, and a narrow pointed process hinged to it (text-fig. 1 d). The ejaculatory apparatus has six rings of spines.

A few specimens only of this species were found in a collection from Colombo Lake, and amongst them was a single male.

The species resembles *Cypria crenulata* Sars very closely, and, indeed, may be but a variety of it, but it differs from it in having knobs on both the anterior and posterior margins of the right shell, and also in the presence of brown spots on the shell. Sars gives no particulars of the structure of the male by which a comparison could be made, but he says that the male is exactly like the female in shape, and that is not quite the case with regard to my own specimens.

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EXPLANATION OF THE PLATES.

PLATE I.

- Fig. 1. *Leydigia australis* var. *ceylonica*. Post-abdomen. $\times 260$.
2. *Chydorus parvus*. Upper lip. $\times 445$.
3. „ „ Post-abdomen. $\times 1050$.
4. „ *barroisi*. Female. $\times 260$.
5. „ „ Post-abdomen. $\times 1050$.
6. *Cyclops distinctus*. Uniting lamella of fourth pair of legs of male.
 $\times 445$.
7. *Canthocamptus grandidieri*. Furcal rami. $\times 445$.
8. „ „ Fifth leg of female. $\times 445$.

PLATE II.

- Fig. 9. *Canthocamptus grandidieri*. Furcal ramus, side view. $\times 445$.
10. *Diaptomus annæ*. Fifth leg of female showing (abnormal) 2-jointed
 endopodite. $\times 445$.
11. „ *viduus*, sp. n. Male. $\times 58$.
12. „ „ „ Prehensile antenna. $\times 120$.
13. „ „ „ Fifth pair of legs. $\times 120$.
14. „ „ „ Part of the right leg of the fifth pair.
 $\times 320$.

PLATE III.

- Fig. 15. *Notodromas oculata*. Dorsal view of female. $\times 98$.
16. *Cypridopsis newtoni*. Right valve of female. $\times 120$.
17. *Oncocypris pustulosa*, sp. n. Dorsal view of moulted shell. $\times 150$.
18. „ „ „ Side view. $\times 98$.
19. „ „ „ Anterior end of left valve from inside.
 $\times 260$.
20. „ „ „ First leg. $\times 445$.
21. „ „ „ Second leg. $\times 445$.
22. *Physocypris tuberata*, sp. n. Dorsal view of female. $\times 98$.

10. On Specimens of the Perciform Fish *Tilapia nilotica* with increased number of anal spines. By G. A. BOULENGER, F.R.S., F.Z.S.*

[Received February 1, 1916: Read April 4, 1916.]

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In the Cichlidæ, as in most Perciform Acanthopterygians, three is the most frequent number of spines in the anal fin, and this number may be looked upon as a primitive character. It has generally been the custom for systematists to attach generic importance to an increase in the number of these spines, even when unaccompanied by any other character. In this I have differed, and refused to accept genera based on the number of anal spines when everything else pointed to close relationship with species showing the usual number, thus uniting Günther's *Oreochromis* (4 anal spines) with *Tilapia* and Pellegrin's *Astatoreochromis* (4 to 6 anal spines) with *Haplochromis*. I felt all the more justified in doing so from the fact that occasionally, as individual exceptions, the three spines may be increased to four, as in *Tilapia mossambica*, *variabilis*, *percivali*, *Haplochromis desfontainesii*. There is also the perplexing case of *Cyrtocara moorii*, of which only two examples are known, one with three anal spines, the other with four. My reform in classification has not met with the approval of Dr. Pellegrin, who has protested against the suppression of his genus *Astatoreochromis*, on the ground that the same character has been used for distinguishing American genera—with what regard to natural affinities appears to me questionable. I think the following fact disposes once for all of his objection.

It is with the greatest surprise that, on recently receiving from Mr. S. L. Hinde a series of over 30 specimens of a fish which I identified as the common *Tilapia nilotica*, a species with which I am familiar from a study of hundreds of specimens, the first I took up showed five anal spines, and the others either four or five. A table showing the variation in 30 of these specimens is here appended. This series was obtained in the Makindu and Isavo Rivers, affluents of the Athi River in British East Africa.

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Makindu and Isavo Rivers, affluents of the Athi River.

1	168	87	77	76	75	73	72	72	65	65	62	62	62	61	59	58	55	54	52	52	52	49	49	44	40
2	.....	18	18	18	17	18	17	18	17	18	18	17	17	17	18	17	18	17	17	17	17	17	17	17	18	18
3	.....	11	10	11	10	11	10	11	10	10	10	12	11	10	10	11	10	10	10	10	11	10	10	12	11	10
4	.....	5	5	4	4	4	4	4	4	5	5	5	4	5	4	5	5	4	5	4	4	4	5	4	5	4
5	.....	10	9	9	10	10	9	10	10	9	9	10	9	10	9	9	10	9	10	9	11	9	10	9	11	9
6	.....	32	31	31	31	31	31	31	31	31	31	31	31	32	31	32	31	32	32	31	32	30	32	32	31	31
7	.....	3½	3½	3½	3½	3½	3½	3½	3½	3½	3½	3½	3½	3½	3½	3½	3½	3½	3½	3½	3½	3½	3½	3½	3½	3½
8	.....	14	14	14	15	14	15	14	15	16	15	15	14	15	14	15	16	16	16	15	15	15	15	14	14	14
9	.....	22	21	21	22	21	19	21	20	21	22	20	22	21	19	21	23	20	20	22	20	20	22	21	22	21
10	.....	13	17	14	12	11	15	14	15	13	13	12	15	12	12	14	14	8	14	12	17	14	12	15	14	11
11	.....	17	17	17	18	18	17	18	17	18	17	19	18	17	18	17	21	17	18	18	17	16	17	17	17	17

1. Total length (in millimetres).

2. Number of dorsal spines.

3. Dorsal soft rays.

4. Anal spines.

5. Anal soft rays.

6. Scales in longitudinal series.

7. Scales in transverse series above the lateral line.

8. Scales in transverse series below the lateral line.

9. Upper lateral line.

10. Lower lateral line

11. Gill-rakers on lower part of
anterior branchial arch.

Having previously received, after writing the description of *Tilapia nilotica* for the 'Catalogue of African Fresh-water Fishes,' two young specimens from another affluent of the same river, the Simba River, it occurred to me to examine them carefully, as I should have done before, and I found four to be the number of spines in both. In their physiognomy, in their coloration and markings, and in all structural particulars, these fishes are indistinguishable from *Tilapia nilotica*; and although, in view of the constancy of the increased number of anal spines, the Athi River specimens may be recognised as a new local form, under the name of var. *athiensis*, I should not think of proposing for them a new species.

A further remarkable fact is the presence of four anal spines in another *Tilapia* very closely related to, though sufficiently distinct from, *T. nilotica*, viz. *T. (Oreochromis) nigra* Gthr., also from the Athi basin. Why in the *Tilapia* from this river-system an increase should have taken place in the number of anal spines is difficult of explanation, unless it be that an abnormal transformation of a soft ray into a spine, as happens elsewhere, should have been a peculiarity of the first settlers in that basin of the widely distributed *T. nilotica*, and, becoming fixed, been passed on to *T. nigra*, which may well be regarded as derived from that species. Whatever this explanation be worth, the fact is clear that, unless our classification of the Cichlidæ be made still more artificial than it unfortunately is at present, the number of anal spines must not be used, as a single character, for the division into genera, and it affords the best justification that could be wished for the course I have followed in the past.

11. On the External Characters of the Mongooses (Mungotidæ). By R. I. POOCK, F.R.S., F.L.S., F.Z.S., Curator of Mammals.

[Received February 22, 1916; Read April 18, 1916.]

(Text-figures 1-10.)

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Introduction.

The facts recorded in this paper are based mainly upon an examination in the Society's Prosectorium of examples of the following genera and species, which have been exhibited during the past ten years in the Zoological Gardens:—

Mungos mungo, the common Indian Mongoose; many specimens of both sexes.

„ *smithii*; one female example from Ceylon.

„ *auropunctatus*; two examples from Nepal and Chittagong.

„ *brachyurus*; one example from the Malay Peninsula, only superficially examined, without drawings being made.

M. m. x „ *gracilis*; one unlocalised example of this African form.

Helogale undulata; two examples from British East Africa very closely allied to this species, but with less yellow in the fur.

Ichneumia albicauda; one female from the White Nile.

Atilax paludinosus; one male from South Africa.

Cynictis penicillata; one example from South Africa.

Ariela fuscata; one female example from the Sudan, representing a local race of this species.

Crossarchus obscurus; two examples, male and female, from West Africa.

Suricata suricatta; two examples, male and female, from South Africa.

I have also seen, in addition to a few examples of some of the species above enumerated, a female specimen of *Bdeogale puisa*, ticketed Zanzibar (Sir J. Kirk), preserved in alcohol in the British Museum.

Although a study of the skulls and teeth has been no part of my present purpose, I have made use of the characters they

supply, in conjunction with the external features, in the attempt to discover the probable affinities of the genera with reference to a hypothetical archaic type of Mongoose. For this, the fine series of skulls in the British Museum has been indispensable.

There does not appear to have been any general work on the classification of Mongooses since the publication of Mr. Thomas's and Prof. Mivart's papers in our 'Proceedings' for 1882. The classification proposed by Mr. Thomas, and the genera he preserved, have been adopted by subsequent authors. It must be remembered, however, that his paper was written before the introduction of the more refined and modern methods of distinguishing genera. Hence there is no doubt that he would now agree in assigning generic rank to *Ichneumia*, to which at the time in question he gave subgeneric rank under *Herpestes*, now known as *Mungos*. I am not aware, however, that there has been published in any faunistic lists a proposal, either tacitly or definitely expressed, to restore *Atilax* and *Ariela* to the generic status formerly given them respectively by Cuvier and Gray. On the available material, Mr. Thomas made *Atilax* a synonym of *Herpestes* (= *Mungos*) and *Ariela* a synonym of *Crossarchus*. My reasons for restoring these names to generic rank are given in the sequel. About *Atilax* there can, I think, be no doubt, assuming the constancy of the features relied upon; and the only criticism, it seems to me, that can be made against the severance of *Ariela* from *Crossarchus* is the uncertainty, in the absence of fresh material, as to the correct generic allocation of all the forms that in recent years have been described as *Crossarchus*. This, however, does not deprive of their force the characters by which the type-species of *Ariela* can be distinguished from that of *Crossarchus*.

As regards the generic names previously proposed, it must not be forgotten that Gray and Hodgson divided what is now known as *Mungos* into several genera—e. g., *Urva*, *Taeniogale*, *Galerella*, etc.,—the type-species of which were cited by Thomas in 1882. It remains to be seen whether any of these genera will be restored in the future or not*. I have not sufficient material upon which to form an opinion of any value; but as at present constituted, *Mungos* is the only genus of Viverroid Carnivores common to the Oriental and Ethiopian Regions.

Two new generic names have been introduced since Thomas's paper, namely, *Paracynictis* for *Cynictis selousi*, and *Galeriscus* based upon *G. jacksoni*, an alleged Musteline from British East Africa, which proves to be a species of *Bdeogale* †.

* The small African Mongoose (*Mungos gracilis*), the type of *Galerella* Gray, differs in several respects from Mongooses of the *M. mungo* and *M. ichneumon* type, notably in its larger ears, less webbed feet, and in the prominence of the anterior chamber of the tympanic bulla. In all these respects it approaches the otherwise very distinct genus *Cynictis*. Another small African species, *M. pulverulentus*, appears to resemble *M. gracilis* tolerably closely, so far as can be judged from dried material.

† Ann. Mag. Nat. Hist. (8) xvii. pp. 176-179, 1916.

The Ear, Vibrissæ and Rhinarium.

The Ear.—The only description of the ear of Mongooses with which I am acquainted is that of Boas ('Ohrknorpel und äusseres Ohr der Säugetiere,' p. 140, pl. xxi. fig. 222, Kopenhagen, 1912), who examined this organ in the common Indian species *Herpestes griseus* (= *Mungos mungo*).

The ear differs in the following particulars from that of all the genera of Viverridæ discussed in my previous papers :—(1) The marginal *bursa* is absent ; (2) the *supratragus* or *plica principalis* is converted into a large movable laminate flap ; (3) above the *supratragus* there is a similar but smaller flap ; (4) the antero-internal ridge curves abruptly backwards into the cavity of the ear, its inferior prominence being set high up and fitting into a hollow above the *antitragus*. By the disposition of these ridges the cavity of the ear is capable of being very completely closed when the ear is folded. The superior flap closes over the space above the *supratragus*, the latter similarly shuts down upon the antero-internal ridge, and the prominence of the latter fits into the space above the *antitragus*, which is itself applied to the ridge representing the *tragus*.

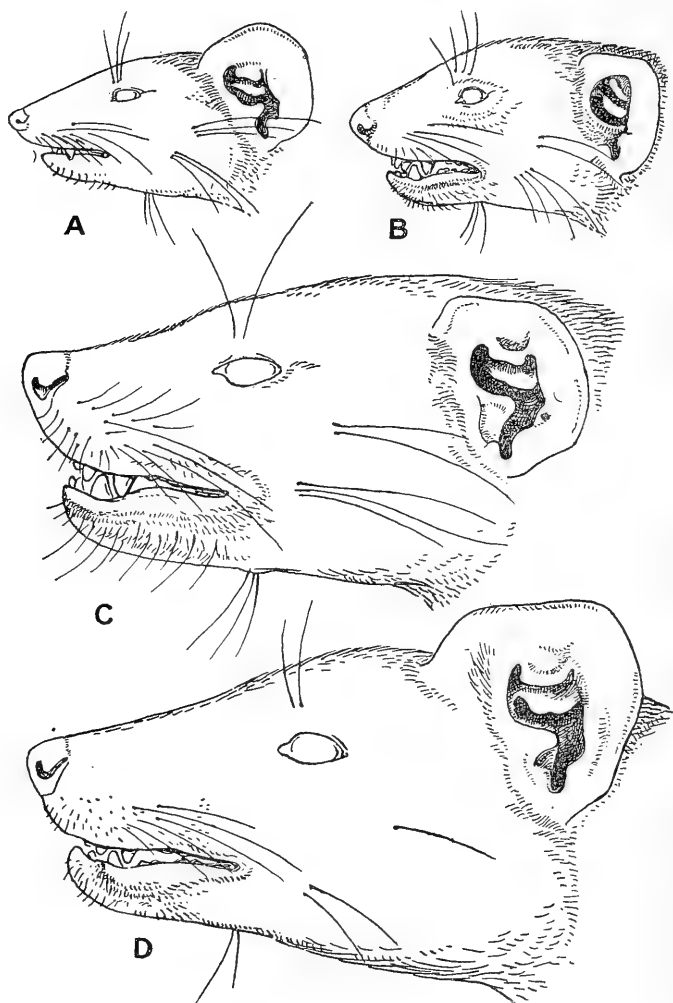
In nearly all the genera the ears are set well behind the eye, are irregularly semicircular in shape, and small, so that the upper margin hardly projects above the line of the occiput and of the nape of the neck ; but in *Cynictis* they are much larger, project well above the head, and have the antero-superior rim rising only a little behind a point above the posterior angle of the eye. In its structural details the ear in this genus is of the same general type as that seen in *Mungos*, *Crossarchus*, *Bdeogale*, and others, with the exception that there is a small shallow pocket behind the *antitragus* (text-fig. 3, A, C). I have not observed this in any other genus, but it is no doubt the homologue of the similarly situated depression in the *Hyænas*, which was regarded by Boas as the representative of the marginal *bursa* in other *Æluroid* Carnivores.

It is perhaps significant that this remnant of the *bursa* persists in the genus which of all the Mongooses has the longest and broadest ears and approaches, in that respect at least, nearest to the *Hyænas*. Nevertheless, the ear of the *Hyænas*, except for the abnormal position and structure of the *bursa*, resembles, broadly speaking, that of other *Æluroidea* *. Some species of *Mungos*, e. g. *M. gracilis* (text-fig. 1, A), have much larger ears than species like *M. mungo* and *M. smithii*. In *Ichneumia albicauda* (text-fig. 1, D) they are also tolerably large ; whereas in *Atilax paludinosus* (text-fig. 1, C), *Ariela fasciata* and *Crossarchus obscurus* (text-fig. 2, A, B) they are comparatively small and rounded. Nevertheless, whatever their size may be, the ears conform closely to the type described in *Mungos mungo* and *M. smithii*.

* See Ann. Mag. Nat. Hist. (8) xvii. p. 333, 1916.

One genus, *Suricata*, stands quite apart from the others in the structure of the ear (text-fig. 3, B, D). This organ is small,

Text-figure 1.

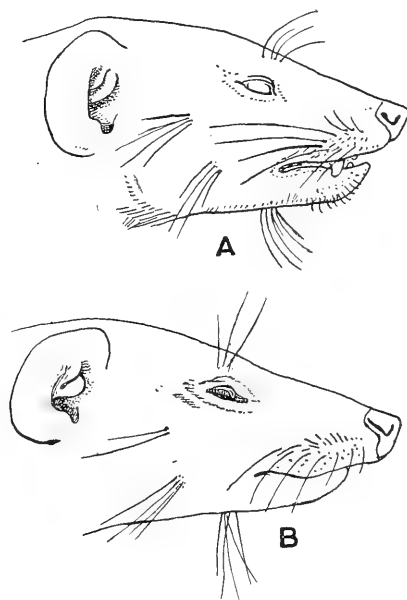


- A. Head of *Mungos gracilis*, from a spirit-specimen, with ear open.
 B. " *Helogale undulata*, from a fresh specimen, " "
 C. " *Atilax paludinosus*, " " "
 D. " *Ichneumia albicauda*, " " "

(All $\frac{2}{3}$ natural size.)

semicircular, and set well back and low down on the head, but it is of a much simpler type than in other genera. There is no lamina above the supratragus, and the latter is a simple thickened ridge. In other respects the ear resembles that of the rest of the genera of Mongooses, differing from the ear of all the Viverridæ in the absence of the bursa and the high position of the prominence of the antero-internal ridge above the antitragus. Amongst the Viverridæ, the Galidictine* genera are those which in the structure of the ear come nearest to *Suricata*.

Text-figure 2.



A. Head of *Ariela fasciata*, from a fresh specimen, with ear closed.

B. " *Crossarchus obscurus*, " " " "

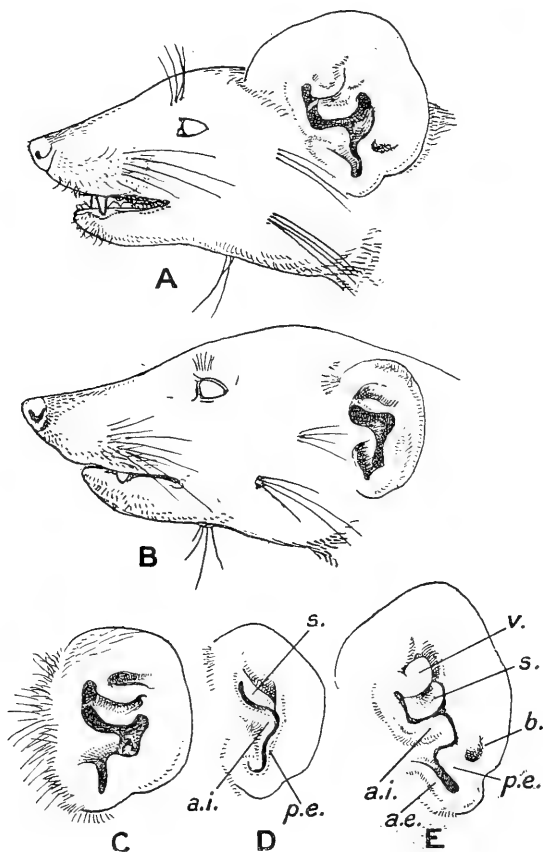
(Both $\frac{2}{3}$ natural size.)

The ear of *Suricata*, in spite of the absence of the two movable laminae, is capable of being closed as tightly as in other members of this group, the supratragal ridge assuming an oblique direction and being pressed against the antero-internal ridge when the ear is folded. That being so, it is difficult to understand the reason for the development of the two laminae in the typical Mongooses. I think, however, it is probable that the close folding of the ear is an adaptation to the known burrowing habits of this group,

* Ann. Mag. Nat. Hist. (8) xvi. p. 354, pl. xv. fig. 4, 1915.

since the Civets, Genets, and Palm Civets, with normal ears, are either scansorial or terrestrial, but not fossorial *. In that case,

Text-figure 3.



A. Head of *Cynictis penicillata*, from a spirit-specimen, with ear open. $\times \frac{2}{3}$.

B. „ *Suricata suricatta*, „ „ „ „ „ „

C. Ear of *Mungos smithii*, open.

D. „ *Suricata suricatta*, closed.

E. „ *Cynictis penicillata*, closed.

v., upper valvular lamina; s., supratragus (plica principalis), forming lower valvular lamina; b., bursa; a.i., antero-internal, a.e., antero-external, p.e., postero-external ridges.

it seems to me possible that the method of closing the ear by means of two laminae, as above described, may serve the purpose

* Not ascertained in the case of the Galidictinae.

of excluding dust and dirt without at the same time excluding sound-vibrations to the same extent as does the arrangement for folding seen in *Suricata*.

Facial Vibrissæ.—In number and disposition the tufts of vibrissæ are quite normal and agree with those of the Viverridæ. But they vary a good deal in development in different forms. Broadly speaking, they are longer and more numerous in smaller than in larger species, as may be seen by comparing *Mungos gracilis* with *M. mungo* or *Ichneumia albicauda* with *Ariela fasciata* and *Crossarchus obscurus*. For instance, the upper genal tuft consists of about three bristles in *M. gracilis* and *Ariela fasciata*, and generally at all events of only one, which is not always detectable, in *M. mungo* and *Ichneumia*.

An exception to this generalisation is seen in *Atilax paludinosus*, one of the largest members of the group. The normal vibrissæ are long, and the anterior mystacials and the submentals are unusually copious and long, giving to the muzzle a hirsute appearance not seen in other species where these particular bristles are comparatively poorly developed (text-figs. 1, 2, & 3).

Rhinarium.—This organ presents no features by which it can be distinguished from that of all genera of Viverridæ. Within the group of the Mongooses it is tolerably constant in form. Its upper anterior margin, viewed from above, is evenly convex from side to side and not mesially notched or sulcate; from the front it is nearly straight or lightly convex, with rounded angles. On the upper surface the narial slits converge slightly, or somewhat markedly, as in *Atilax*, and are bordered externally by a narrow rim of naked integument; the posterior border is usually lightly concave, but in *Atilax* the hairs of the muzzle overgrow it to a greater extent, forming an angular excision in the naked skin. The infranarial portion of the anterior surface is always well developed, and generally transverse from side to side along the lower margin; but in *Atilax paludinosus*, in which the whole rhinarium is broad, the infranarial portion is especially deep and its edges diverge a little upwards and outwards from the middle line. The median sulcus, with which the anterior surface is marked in some forms, never apparently passes higher than the upper edge of the nostrils.

As has been pointed out by Gray, Thomas, and others, the inferior edge of the rhinarium may or may not be continued down the middle line of the upper lip as a strip of naked skin. This strip is present in the genera *Mungos*, *Helogale*, *Ichneumia*, *Atilax*, *Bdeogale*, and *Cynictis**, and absent in *Rhynchogale*†, *Ariela*, *Crossarchus*, and *Suricata*, in which the skin of the upper lip is continuously hairy across the middle line. When this strip is present, it is always grooved, and in a great majority

* In the 'Fauna of South Africa,' Mamm. i. p. 73, 1900, Mr. W. L. Sclater places *Cynictis*, with *Suricata* and *Crossarchus* (= *Ariela*), in the category in which the lip is undivided. This is an error.

† I have never seen a fresh or alcohol-preserved adult example of this genus.

of cases the groove is continued upwards on to the rhinarium. In *Cynictis*, however, the groove does not quite reach the rhinarium and is confined to the upper lip, where it is nothing but an impressed line, not a definite gutter, dividing the median naked area of skin. In the other genera of Mongooses possessing this feature, the median naked area forms a gutter capable of expansion and contraction. When contracted, it closes up completely and is represented superficially by a linear groove, the right and left hairy areas of the upper lip being in contact in the middle line. In *Cynictis*, therefore, we have a condition of the upper lip nearly intermediate between the condition seen in *Mungos*, with the guttered upper lip, and *Ariela*, with the undivided upper lip.

The depth, or height, of the upper lip beneath the rhinarium varies. In most genera it is less than the depth of the rhinarium. But in *Ichneumia albicauda* the lip is deeper—as deep, indeed, as the rhinarium. The same applies to *Crossarchus obscurus*; but in this animal the rhinarium is relatively much deeper than in *Ichneumia*, owing to the unusual depth of the infranarial portion in front. Hence the lip itself is also relatively deeper. It is the combined depths of the rhinarium and lip which impart to *Crossarchus* the very characteristic somewhat pig-like appearance about the snout—an appearance not noticeable in any other species of Mongoose except *Suricata* *.

Normally in Mongooses, as in other Carnivores, the two portions of the upper lip to the right and left of the groove are closely in contact, the groove itself appearing as a narrow vertical line. The function of the groove is to help the separation of the two halves of the lip when raised to clear the teeth. When the groove is obliterated, the snout is raised, thus drawing the lip upwards away from the teeth, a phenomenon very noticeable in such forms as *Procyon* and *Nasua*. In all Carnivora it seems that elongation of the snout does not take place without obliteration of the groove; but the condition of the snout in *Ariela* shows that it is not true to say that obliteration of the groove always accompanies elongation of the snout.

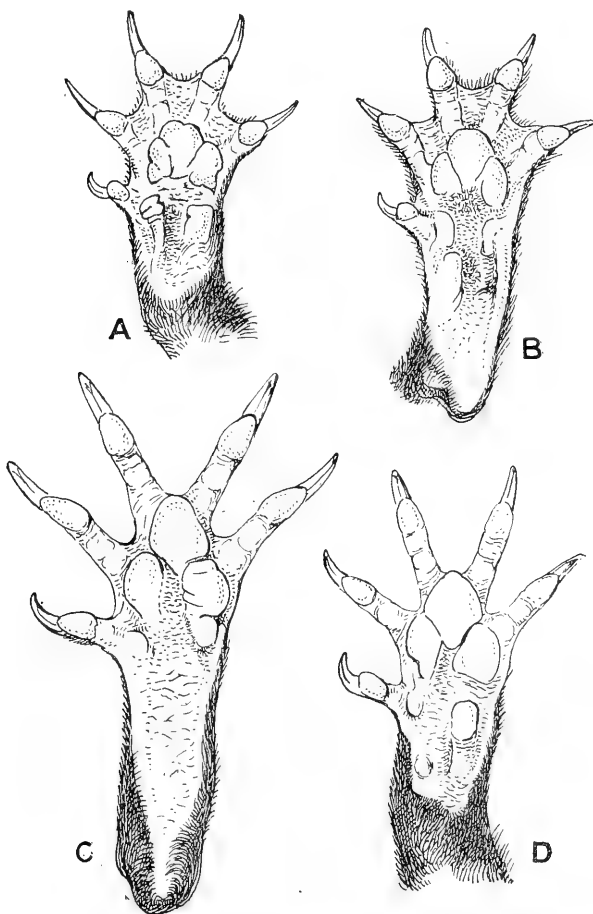
The Feet.

Setting aside the variations recorded below, the feet of Mongooses have the following characters in common. The claws are moderately long or very long, curved to a comparatively small extent, and incapable of being lifted high off the ground by the retraction of their phalanx upon the outer surface of the penultimate phalanx, and the tips of the digits at the base of the claws are never provided with lobes of skin or thickly-growing hair. The digital pads are small. The plantar pad is

* The name *Rhinogale*, and its substitute *Rhynchogale*, suggest a similar modification of the snout in that genus. The adult of this rare animal is, however, known to me only from dried skins, in which the real length of the snout cannot be determined.

well developed, cushion-like and trilobed, and the area between it and the digital pads, whether webbed or not, is naked. The hallux and pollex, when present, are shortish or very short and set above the plantar pad; and the hallucal and pollical lobes of

Text-figure 5.

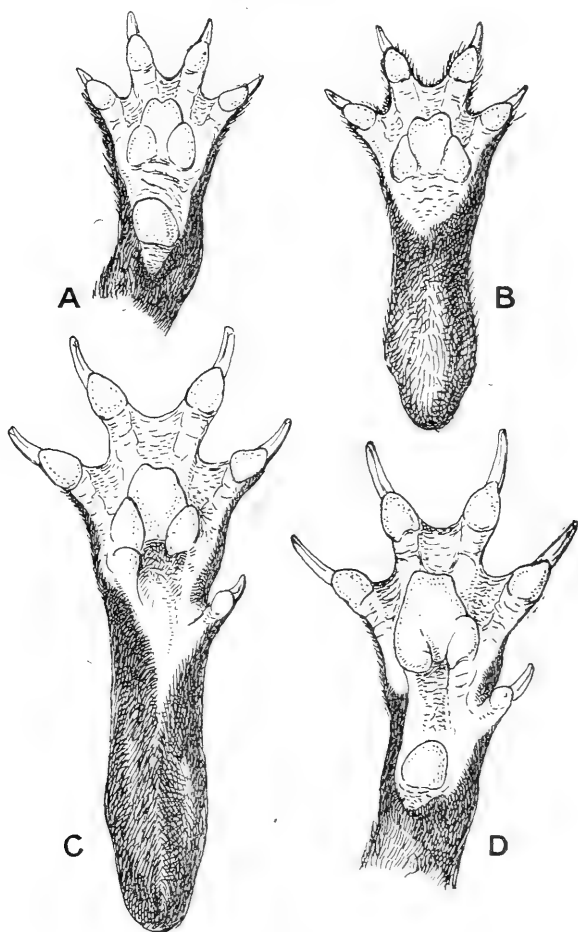


A. Left fore foot of *Mungos smithii*. . . $\times \frac{3}{2}$.
 B. " hind foot " " "
 C. " fore foot of *Atilax paludinosus*. " "
 D. " hind foot " " "

the plantar pad are small or obsolete, and detached from the plantar pad. A single or double carpal pad is always present, and separated by a naked tract from the plantar pad.

Judging from the analogy supplied by other Carnivores, the ancestral foot of the Mongooses was pentadactyle and plantigrade, and furnished with well-developed interdigital webs and naked soles.

Text-figure 6.

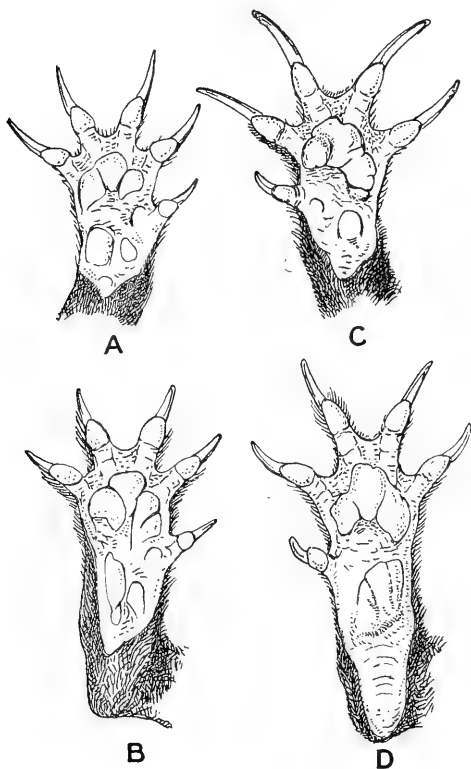


- | | | |
|----|--|------------------------|
| A. | Right fore foot of <i>Bdeogale puisa</i> . | $\times \frac{2}{3}$. |
| B. | " hind foot " " | " " |
| C. | " " <i>Ichneumia albicauda</i> . | " " |
| D. | " fore foot " " | " " |

The feet of several of the genera conform to this type, and those of *Mungos* may be taken as an illustration and as a standard with which the feet of other genera may be compared.

In a specimen of *Mungos smithii*, a Ceylonese species, the fore foot is entirely naked beneath as far back as the carpus. The digits, when spread, are seen to be slightly asymmetrically arranged. The four main digits are united by webbing which extends proximally up to the inner or admedian portion of the rather small digital pads. Nevertheless they are capable of

Text-figure 7.

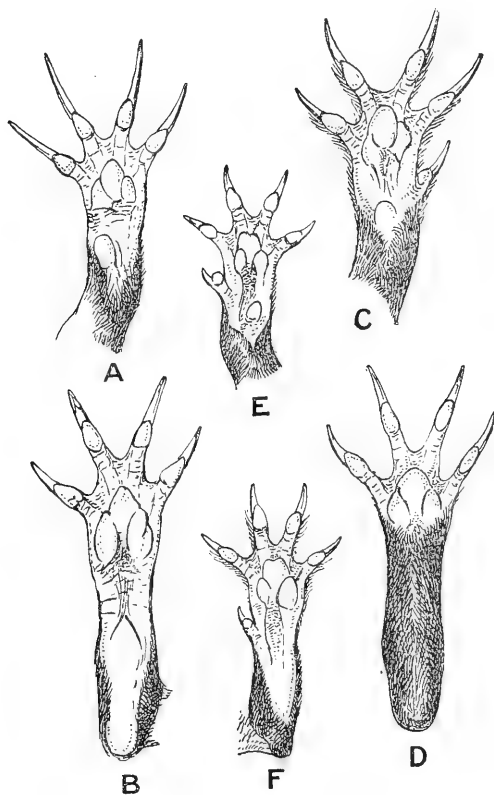


- A. Right fore foot of *Crossarchus obscurus*. $\times \frac{2}{3}$.
 B. " hind foot " "
 C. Left fore foot of *Ariela fasciata*. "
 D. " hind foot " "

being more widely divaricated than is the case in the arboreal or terrestrial genera of *Viverrinæ* and *Paradoxurinae*. The claws are longish. The pollex is quite short, does not project laterally so far as the second digit, and is inserted higher up the foot than the adjacent portion of the plantar pad; its claw is well

developed, but smaller than that of the other digits. The plantar pad is swollen, trilobed and asymmetrical, the external lateral lobe being a little larger and extending higher up the foot than the internal lateral lobe. The distal margin of the median lobe

Text-figure 8.



- | | | |
|----|--|------------------------|
| A. | Right hind foot of <i>Suricata suricatta</i> . | $\times \frac{2}{3}$. |
| B. | " hind foot " " | " |
| C. | " fore foot of <i>Cynictis penicillata</i> . | " |
| D. | " hind foot " " | " |
| E. | Left fore foot of <i>Mungos gracilis</i> . | " |
| F. | " hind foot " " | " |

is broadly truncated, and extends obliquely backwards and outwards to the point where it meets the external lobe. There is a small pollical lobe, but it is detached from and higher up than the posterior extremity of the internal lateral lobe of the plantar pad. The larger carpal pad occupies a similar position with

regard to the posterior end of the external lateral lobe. It is on the outer side of the middle line of the foot, and between it and the edging of hair there is a naked area of considerable size.

The hind foot agrees with the fore foot in all essential respects, but the digits are more symmetrically disposed and the claws are shorter. There is a small detached hallucal lobe, and above the latter and on the corresponding area on the outer side of the foot there are feeble indications of right and left metatarsal ridges. The whole of the metatarsus is naked, and the nakedness extends to the tip of the calcaneum (text-fig. 5, A, B, p. 358).

Sketches of the feet of several examples identified as *Mungos mungo*, the commonest of the Indian Mongooses, show a close general resemblance to the feet of *M. smithii* described above, except that the pollex and hallux are set a little higher and the edges of the main interdigital webs are a little more emarginate; but without further examples of *M. smithii*, it would be unwise to attach systematic importance to these differences.

An example of *M. auropunctatus* from Chittagong also has feet of this type; but the interdigital webs are more emarginate than in *M. mungo*—that is to say, when the digits are separated the edges of the webs project to a rather lesser extent beyond the lobes of the plantar pad. In this species, moreover, the hallux is much smaller than the pollex, a disparity in size not noticeable in the examples of *M. smithii* and *M. mungo* examined.

The only representative of the African species of *Mungos* I have examined is a spirit-specimen of *M. gracilis* *. In this individual the feet are much more delicately formed than in the Indian species, being narrower, with smaller pads and with the webs considerably shallower even than in *M. auropunctatus*, and both hallux and pollex are small and set high up the foot; but the claws of all the digits are short. Except for the shortness of the claws and the retention of the hallux, the feet of *M. gracilis* are nearly intermediate in structure between those of *M. mungo* and *Cynictis* (text-fig. 8, E, F, p. 361).

Although the number of species and specimens of this genus examined is small, a certain amount of variation in the depth of the interdigital webs is noticeable. This feature will probably be found useful for distinguishing species when investigated in forms hitherto unexamined.

One other character is known to be variable, as Thomas has shown for the African and Blanford for the Indian species, namely, the extent to which the heel is covered with hair. This feature may vary within the limits of a single species, e. g. *M. ichneumon*; and in *M. urva* the upper part of the metatarsus as well as the tarsus is hairy.

In *Helogale* the feet recall those of the Indian species of *Mungos*, but, if anything, are more robust, with the webs

* Peters figured the soles of the feet of this species under the name *M. ornatus* ('Reise nach Mossambique,' Säug. pl. xxvi., 1852). The shallowness of the webs is shown, but details of the plantar pads are not indicated.

more deeply emarginate. The hair on the carpus reaches the carpal pad, which has a supplementary lobe at the base on the inner (pollical) side. In the hind foot the hallux is small, smaller than the pollex, as in *Mungos auropunctatus*, and the heel is hairy, when the hairs are not worn off.

Peters' figures of the feet of typical *H. undulata* from Mozambique differ in some respects from those of the examples of this genus I have seen ('Reise nach Mossambique,' Säug. pl. xxv., a, b). In the fore foot the hair does not reach the carpal pad, which is small and single, and the pollex is set higher up the foot. In the hind foot a larger extent of the underside is overgrown with hair. But the complete absence of detail in the outline of the plantar pads does not attest care in the execution of these figures*.

The feet of an example of *Atilax paludinosus* from South Africa differ from those of *Mungos* in one or two particulars, notably in the complete suppression of the interdigital webs, the digits being separated right down to the plantar pad. Both pollex and hallux are long. The plantar pad is elongated and distally narrowed, the apex of the median lobe being less truncated than in *Mungos*, and the two lateral lobes are set relatively a little farther back. Small pollical and hallucal lobes are retained, but are detached from the posterior angle of the internal lateral lobe of the plantar pads. In the fore foot, the carpal pad is elongated and set on the external side of the middle line of the naked carpal area. The hind foot shows no distinct traces of metatarsal pads, and in the example examined the whole of the metatarsus was naked beneath, and a naked strip of skin extended along the underside of the heel to its tip, but, as Thomas has shown, the degree of hairiness of the tarso-metatarsus varies considerably within the species, this area sometimes being naked as in the specimen described above, sometimes the heel alone being hairy, and sometimes the hair extending nearly as low as the plantar pad. I am not aware whether geographical races have been studied from the standpoint of this character, or not.

The absence of the interdigital webs in this Mongoose constitute, in my opinion, a valid reason for resuscitating the genus *Atilax* (text-fig. 5, C, D).

In an example of *Ichneumia albicauda* from Dufle (White Nile) the feet are slender and longish, with decidedly emarginate webs, recalling in these respects those of *Mungos gracilis* rather than of *M. mungo* or *M. smithii*. The hallux and pollex, about equal in size, are set well above the plantar pad. The carpal pad is semielliptical, of moderate size and higher than the

* In systematic works, *Helogale* is merely distinguished from *Mungos* by the suppression of the diastema between the canine and pm.² of the upper jaw, pm.¹ being absent, as sometimes occurs in *Mungos*. As living animals, *Helogale* and *Mungos* are very different in appearance, the former being a squat little creature with a comparatively short tail and a broad head with short, pointed muzzle.

pollex, with only a narrow strip of naked skin above it. In the hind limb the hairs, as recorded by others, extend all over the back of the metatarsus practically down to the hallux. Judging from dried skins, there does not appear to be any marked variation within the species in the hairiness of the metatarsus (text-fig. 6, C, D, p. 359).

This Mongoose is more digitigrade and stands higher on its legs than any member of the group of which I have seen living specimens, not excepting even perhaps *Atilax paludinosus*.

In *Ariela fasciata* the fore foot closely resembles that of *Mungos* except that the digits and the naked area behind the plantar pad are relatively a little shorter, the claws longer, and the interdigital webs somewhat shallower. The hind foot is rather narrower than in *Mungos*, the lateral interdigital webs are much more deeply emarginate, whereas the median web between the third and fourth digits is about as deep as in *Mungos* but ties the toes a little closer together. The hallux is as large as the pollex. The sole of the foot is naked back to the tip of the calcaneum, and a little behind the plantar pad there are traces of suppressed metatarsal pads (text-fig. 7, C, D, p. 360).

The fore foot of *Crossarchus obscurus* does not differ from that of *Ariela fasciata* except that the carpal pad is larger and has a small supplementary lobe on its inner or pollical side, as in *Helogale*, but detached from the main part of the pad. The hind foot is relatively shorter than in *Ariela fasciata*, owing to the shortness of the third and fourth digits. In the specimens examined, the heel, when unworn, is hairy*, the naked area of the metatarsus corresponding exactly with that of *Helogale*. This area exhibits a pair of low elongated metatarsal pads, of which the external projects farther forwards than the internal (text-fig. 7, A, B).

In *Cynictis penicillata* the hind foot, as has been often stated, is hairy below down to the plantar pad, and differs from that of the genera hitherto recorded in the total suppression of the hallux. The whole foot is comparatively long and narrow, and the webs are very shallow, those between the second and third and the fourth and fifth digits extending only slightly beyond the plantar pad on each side, and although the web between the third and fourth digits is a little deeper, it only passes about half-way up the admedian margin towards the digital pads, which, like the digits themselves, are narrow. The claws are long. The three lobes of the plantar pad form a tolerably evenly cordate mass narrower than in *Mungos* and *Crossarchus*. The fore foot closely resembles the hind foot, but the claws are longer, the interdigital webs are a little deeper, and the pollex, carrying a long claw and set high above the plantar pad, is retained, although short. The area between the plantar pad and the small submedian carpal pad is quite naked (text-fig. 8, C, D, p. 361).

* Perhaps a variable character, since Thomas (P. Z. S. 1882, p. 86) mentioned the nakedness of the hind soles amongst the generic characters of *Crossarchus*.

The genus *Paracynictis**, recently established for the species described by de Winton as *Cynictis selousi*, seems to resemble *Cynictis* in the structure of the feet except that the pollex is suppressed, as well as the hallux. In this respect the feet resemble those of *Suricata* and *Bdeogale*.

The feet of two species of *Bdeogale*, namely, *B. puisa* and *B. crassicauda*, have been figured by Peters†. Although the details of the plantar pads are not very clearly shown, the drawings are tolerably accurate, judging from a spirit-preserved example of *B. puisa*, ticketed "Zanzibar (Sir J. Kirk)," in the British Museum. In this example the feet are, on the whole, very symmetrical with respect to the plantar pads and the digits. The latter are shorter and a little thicker than in *Mungos*, but are webbed approximately to the same extent. There is no trace externally of hallux or pollex. The carpal pad is large and submedian in position, but with a slight external inclination. Behind it there is a small triangular area of naked skin, and in front of it a broad naked area separates it from the plantar pad. All trace of the pollical lobe has disappeared with the pollex. In the hind foot there is a semicircular area of naked skin behind the plantar pad. Apart from this, the entire posterior surface of the metatarsus is covered with hair; and judging from dried skins, the hair in some species extends right down to the plantar pad. In other respects the structure of the feet in this genus is apparently tolerably uniform (text-fig. 6, A, B).

The last of the tetradactyl Mongooses is *Suricata*. In length and narrowness the feet resemble those of *Cynictis*. The claws are perhaps a little longer, and the webs are deeper, but they are not so deep as in *Mungos*, being developed to approximately the same extent as in *Ariela*. On both the fore and the hind foot the web between the third and fourth digits is deeper than the others, and on the hind foot the web between the third and fourth is deeper than that between the fourth and fifth digits. The digits are less symmetrical than in *Cynictis*, and markedly asymmetrical as compared with those of *Bdeogale*. The carpal and plantar pads are normal in development, and the external lobe of the plantar pad of the hind foot is larger, sometimes much larger than the internal lobe. The area above the plantar pad on the hind foot is naked to the tip of the heel, and towards the heel this area rises into a wide, low, laterally expanded pad-like eminence which gives a sinuous outline to the naked tarso-metatarsal area ‡ (text-fig. 8, A, B).

* Ann. Mag. Nat. Hist. (8) xvii. p. 177, 1916. An examination of dried skins suggests that the area between the carpal and plantar pads may be overgrown with hair, thus contradicting the generalisation (p. 358) as to the nakedness of this area in Mongooses.

† 'Reise nach Mossambique,' Säug. pls. xxvii. & xxviii., 1852.

‡ Accounts of the metatarsal area vary. Thomas and, following him, W. L. Slater correctly described this area as naked. But Mivart and, following him, Flower and Lydekker wrongly described it as covered with hair. Its naked condition does not seem to be subject to variation.

From the accounts above given, it is clear that the feet of Mongooses exhibit a wide range of variation in such characters as the numbers of the digits, the hairiness of the tarso-metatarsal area, and the presence and extent of the interdigital webs. These characters are either invariable or subject to much less variation in other groups of corresponding rank amongst the *Æluroides*. There is only one group of the suborder, however, which possesses feet structurally recalling those of the Mongooses, namely, the *Galidictinæ*, the feet of which I have recently described and figured*. Between the feet of *Galidictis* and one of the pentadactyle, semiplantigrade Mongooses, like *Mungos*, there appear to be only two differences which call for notice. In *Galidictis* (and in *Galidia*) the pollex and the hallux are set lower on the foot and project therefrom on a level with the internal lateral lobe of the plantar pad, and the pollical and hallucal lobes of this pad are better developed and in contact with the internal lateral lobe. Hence the plantar pad is quadrilobate, whereas in *Mungos* and all other genera of Mongooses the plantar pad is trilobate. It may also be added that the metatarsal and carpal pads in *Galidia* and *Galidictis* are better developed than in the Mongooses and are double.

These differences are interesting because they show that the feet of the *Galidictinæ* are of a more primitive type and, on the whole, more Viverrine than are those of the Mongooses. Nevertheless it cannot be claimed either that the feet of *Mungos* differ more from those of *Galidictis* than they differ from the feet of *Bdeogale*, *Atilax*, or *Suricata*, or that the feet of *Galidictis* differ more from those of *Mungos* than they differ from the feet of the *Paradoxurine* genera or of *Eupleres*.

The Glandular Anal Sac.

The presence of a glandular anal sac in Mongooses has long been known; but its invariable occurrence within the group has been disputed. I have found it without exception in all the specimens I have examined, even in those belonging to species in which its existence has been denied. Cuvier, for example, said that the Marsh-Mongoose, which he named *Atilax vamsire*†, is without it. It happens, on the contrary, to be rather exceptionally well developed in that form (text-fig. 9, B, C). It is also present, though small, in *Mungos auropunctatus*, despite Mivart's statement‡ that in a living example he examined "the anus opened most distinctly on the surface of the body, and not into a saccular depression." Since Mivart was probably the authority for Blanford's declaration§ that "this character is

* Ann. Mag. Nat. Hist. (8) xvi. pp. 351-356, pls. xiv., xv., 1915.

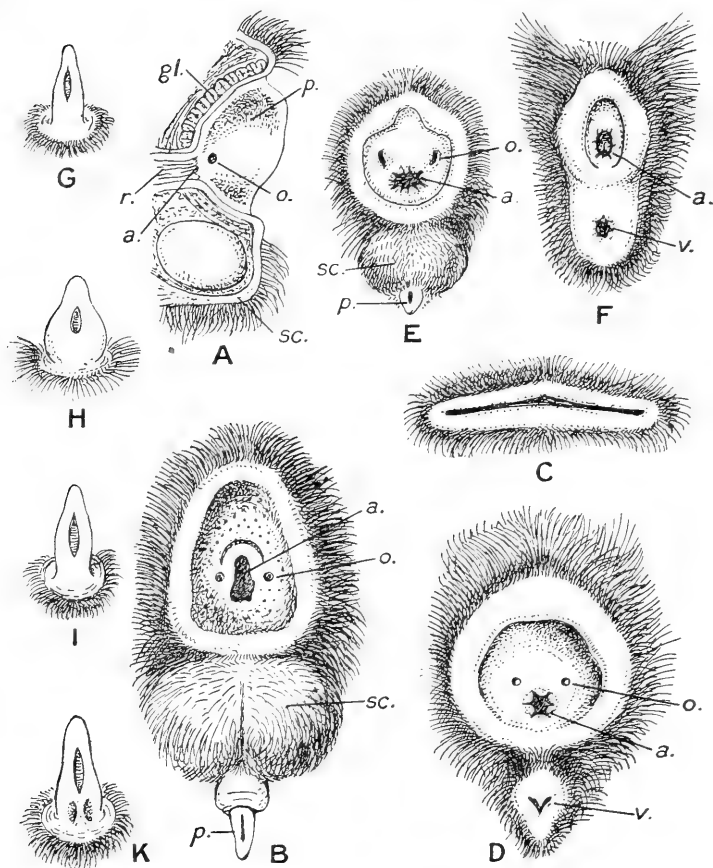
† St. Hilaire & Cuvier, Hist. Nat. Mamm. ii. pt. 54, pl. 198, 1826.

‡ Proc. Zool. Soc. 1882, p. 178.

§ 'Fauna of Brit. India': Mammalia, p. 119, 1888. It is a pity Blanford did not particularise the species, and say whether his information was based upon his own observations or not. It may here be recalled that Murie and others entirely failed to find the large anal sac in a living Spotted Hyæna.

ill-marked or absent in some of the common Indian species" [of *Mungos*], it may be explained at once that Mivart evidently

Text-figure 9.



- A. Longitudinal section of anal area of *Atilax paludinosus*, ♂. p., anal pouch; gl., cutaneous glands of pouch; o., orifice of anal gland; a., anus; r., rectum; sc., scrotum with testis.
- B. Anal area of the same. Lettering as in A, with p., penis.
- C. Anal pouch of the same, closed.
- D. Anal pouch of *Ichneumia albicauda*, ♀. Lettering as in A, with v., vulva.
- E. The same of *Cynictis penicillata* (young ♂). Lettering as in B.
- F. The same of *Bdeogale puisa*, ♀. Lettering as in D.
- G. Glans penis of *Crossarchus*, from below.
- H. The same of *Suricata*.
- I. The same of *Cynictis*.
- K. The same of *Mungos mungo*.

did not distinguish between the orifice of the sac and that of the rectum which lies within it. That this would be a difficult task in a living animal is quite credible. Indeed, in such a form as *M. auropunctatus*, it is easy at first sight to believe that the sac itself is merely an enlarged anus, that its thickened rim is the anal sphincter, and that the small rectal orifice within the sac arises from constriction of the gut just within the anus; and this view would be strengthened by the discovery of the apertures of the anal glands well outside the inner orifice and not within it, where, by the analogy of other carnivores, they should be situated if the orifice in question were the anus. There are reasons which make me judge that conclusion to be wrong. In the first place, the external orifice of the sac is not shut by the constriction of a circular sphincter muscle as the anus is; but when closed it forms a transverse, sometimes crescentically upcurled, rima by the juxtaposition of its upper and lower margins (text-figs. 9, C, and 10, A). In the second place, the walls of the sac, sometimes at all events, show short hairs projecting from the cutaneous follicles, suggesting its origin from the involution of hairy circumanal integument. Finally, the inner orifice itself is provided with a sphincter muscle. The external position of the apertures of the anal glands, although unusual, is not without parallel in the Carnivora, as is attested by the condition seen in *Hyæna* and *Proteles*.

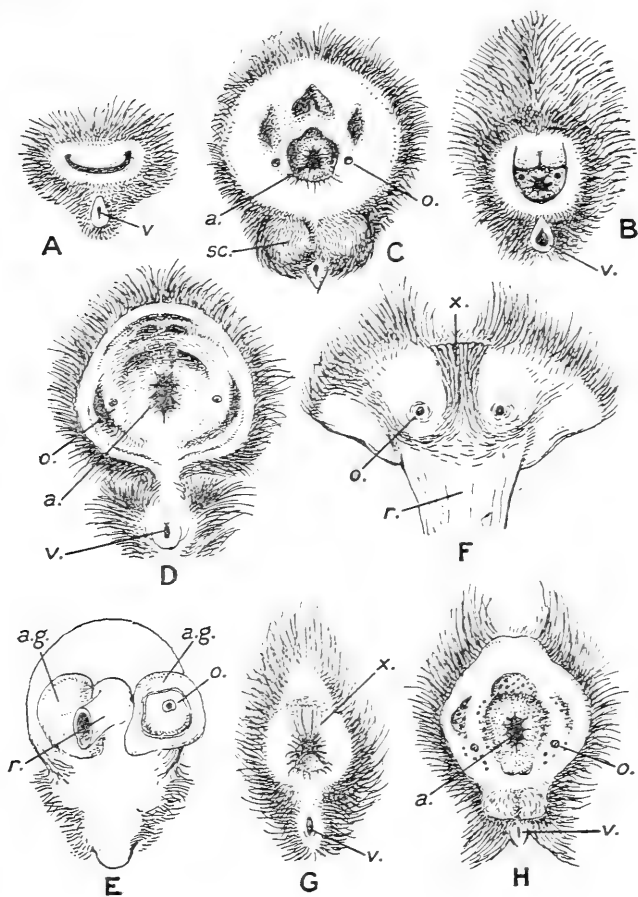
In the Mongooses the position of these apertures varies. Usually they are set one on each side of the anus, and tolerably close to it (*Mungos mungo*) or removed to some distance from it (*Ariela*, *Suricata*). In other cases they are placed somewhat (*Ichneumia*) or considerably (*Cynictis*) higher up in the anal sac (text-fig. 9, D, E).

The secretion of these glands is always liquid and foul-smelling and often copious. But, in addition, the free wall of the sac is provided with well-developed cutaneous glands of the ordinary kind, sometimes fairly uniformly distributed (*Atilax*), sometimes especially active and large in a half circle above the anus (*Mungos*), sometimes located in definite paired areas of the sac.

Three of the genera, however, call for more detailed notice, since the published descriptions of their glands do not agree in all particulars with my observations.

When claiming for the first time the close and congeneric affiliation between *Crossarchus obscurus* and *Ariela fasciata*, Thomas added the following paragraph (P. Z. S. 1882, p. 86, note):—"Since the above was written, Prof. Mivart has pointed out to me that the researches of Chatin into the structure of the anal glands of the Carnivora (Ann. Sci. Nat. (5) xix. p. 89, 1874) fully confirm the opinion here expressed as to the generic relationship of the Striped Mongoose (*C. fasciatus*) with *C. obscurus*." Chatin does not, however, mention *C. obscurus* in the paper referred to; and that Thomas was misled by Mivart is clearly shown by the remarks of the latter on the subject in question

Text-figure 10.



- A. Closed anal sac of *Helogale undulata*, ♀. v., vulva.
 B. Anal sac of the same, partially distended.
 C. Anal sac of *Helogale undulata*, ♂, on a larger scale, fully distended, and showing glandular pouches or depressions. a., anus; o., orifice of anal gland; sc., scrotum.
 D. The same of *Ariela fasciata*, ♀. Lettering as in preceding figures.
 E. The same, dissected and seen from within, showing the single pair of normal anal glands (a.g.), that of the left side opened to show orifice (o.) into sac; r., rectum turned aside.
 F. Anal sac of *Crossarchus obscurus*, ♀, cut from below and spread open. r., rectum, cut open; x., fine cutaneous ridges extending from upper margin of sac to anus; other lettering as above.
 G. The same anal sac shown partially distended when the tail is raised.
 H. Anal sac of *Suricata suricatta*, ♀, distended to show the glandular depressions, with the scrotum-like swelling between the vulva and the lower rim of the sac.

(P. Z. S. 1882, p. 183):—"The anus opens into the middle of a very large and deep fossa, into which several pairs of anal glands also open. The structure of these parts is described by M. Chatin as they exist in both species. The condition found in *C. obscurus* is described by him in . . . C. R. Assoc. française, i. p. 557, 1872. The parts of *C. fasciatus* are described and figured by him (under the name of *Herpestes fasciatus*) in the Ann. des Sc. Nat. vol. xix. (5th series) 1874, p. 89, figs. 29-33 & 38. No less than five pairs of glands are arranged about the anus, and pour their secretion into the capacious and naked anal pouch."

Reference to these two papers shows that the second is merely an amplified edition of the first. *C. obscurus* is not mentioned in either. It is *C. fasciatus* that is described in both, and Chatin does not even quote the first publication in the second. He was clearly unacquainted with *C. obscurus*, at all events so far as the organs under discussion are concerned. Hence Mivart's above quoted summary of Chatin's description of the anal sac and glands in *Crossarchus* applies solely to *C. fasciatus*, and Thomas's claim of affinity between the two species derived from Mivart's information falls to the ground.

In a male and a female example of *Crossarchus obscurus* (text-fig. 10, F, G), I find the anal sac and glands resemble in a general way those of typical Mongooses of the genera *Mungos* (= *Herpestes*), *Bdeogale*, and *Helogale*. The anus is sunk in a central subcircular depression surrounded by an upstanding thickened rim which is about equal in thickness to the transverse diameter of the depression. The skin of the superior or caudal area of this thickened rim is furnished with a number of fine longitudinal laminae which pass into the central depression above the anus, where they break up into wrinkles set for the most part transversely between the anus and the two orifices of the anal glands. These orifices are quite conspicuous, open in the ordinary position, and lead into glandular reservoirs of average size.

Thus the anal glands and anal sac in both sexes of *Crossarchus obscurus* differ very considerably from those of the male *Ariela fasciata* described by Chatin.

A female of *Ariela fasciata*, or of a closely-allied form brought by Mr. G. Blaine, F.Z.S., from the Sudan (text-fig. 10, D, E), has a very large anal sac as compared with that of most species of Mongooses. Its surface is marked with three pairs of integumental folds or depressions—two pairs above and one pair at the sides of the anus. The depressions of the upper of the supra-anal pairs are situated close together immediately beneath the upper rim of the anal sac, and are sunk in a common fold of the skin. Those of the lower of the supra-anal pairs are beneath them, but more widely separated and nearer the anus. Those of the lateral pair are placed far out towards the lateral rim of the anal sac. They are much longer than the others, and approximately follow the curvature of the rim of the sac, but come to an

end on each side before reaching the middle line beneath the anus.

Each of the depressions or folds above described contains a small glandular pit with several secreting pores, and the glands beneath these pores appear to be simple enlargements of the ordinary sebaceous or follicular glands of the skin. It is quite clear that none of them represents the true anal glands of other Carnivores. The orifices of these are situated on each side of the anal sac close to the inner margin of the lateral folds. The glands themselves are a pair of large muscular sacs filled with dark-coloured, strongly smelling, oily fluid which escapes to the exterior through the orifices above described. These glands are quite different from the smaller glands of the anal sac in their size, their saccular character, and the nature of their secretion.

The character of the anal glands in this Sudanese female example of *Ariela fasciata* explains much that was puzzling in Chatin's description of the glands in a male of the species from South Africa. As has been already stated, Chatin assigned to that species five pairs of anal glands opening by as many orifices in folds upon the surface of the anal scent-pouch. These glands he named the anterior, the lateral, the intermediate, the lateral posterior, and the median posterior. It is not easy to homologize all of these precisely with the glands I have described in the female. But judging from their position and size, the lateral glands appear to be the true anal glands, the median posterior are evidently those that I have called the upper supra-anal, while the intermediate and anterior probably correspond respectively to the lower supra-anal and the lateral, the lateral portions being undifferentiated in the female.

The principal difference, however, between the glands of the two animals consists in this:—In the female the secondarily specialised glands appear to be ordinary sebaceous or follicular glands but little modified and quite distinct from the true anal glands, whereas in the male they have been modified so as to resemble approximately the true anal glands—that is to say, each consists of a wall of secreting cells surrounding a sac or hollow for storing the secretion, which is similar in nature to that of the anal glands in being brown in colour and fœtid in odour. This secondarily acquired similarity—an exceedingly interesting fact—seems to have misled Mivart into thinking that the two normal anal glands present in all *Æluroid* Carnivores had become broken up, as it were, in the male *Ariela fasciata* into the five pairs of glands described by Chatin (*Ann. Sci. Nat.* (5) xix. pp. 89–93, pl. iv. figs. 29–30, 1874).

The existence of a pair of saccular anal glands in *Suricata* was, as Mivart states, recorded by Daubenton. To this Mivart adds:—“The anus opens into the middle of a very deep fossa, deeper than that of *Bdeogale* and like that of *Crossarchus*. . . . I strongly

suspect, from the form of the anal pouch, that there are here, as in *Crossarchus* *, several pairs of anal glands."

This is not the case in the examples of *Suricata suricatta* I have examined.

In a male the anal sac resembles that of *Mungos mungo* in a general way, but is relatively larger. It is marked on each side of the anus by a transversely oblique slit-like depression, and not with several depressions as in *Ariela fasciata*. Its surface is pitted with comparatively large and quite conspicuous hair-follicles, and from most of these, perhaps all normally, a single hair or a little tuft of hairs arises. Under pressure liquid secretion can be squeezed from the pores of these follicles, which are particularly numerous in the oblique depression above described. When expanded, the depression is seen to curve downwards towards the lateral margin of the anal pouch, and the orifice of the anal gland is situated just below its deepest portion, but is concealed within it when the depression is unexpanded. There is a single moderate-sized gland on each side, as Daubenton said; and I can find no evidence for the multiplication of similar glands such as Chatin described in the male *Ariela fasciata*. On the contrary, sections of the highly glandular hair-follicles show them simply imbedded in the thickened skin of the anal pouch without coalescing to form composite glands with reservoirs for the storage of secretion. In its glandular character the anal pouch recalls that of the female *Ariela fasciata*, with the exception that the hair-follicles are more irregularly scattered and not aggregated in so many definite integumental depressions.

In a female (text-fig. 10, H) the gland is similar to that of the male, and apparently as well developed. The two orifices of the anal glands perforate the walls of the sac nearly midway between its lateral border and the anus. The integument of the sac round about them is pitted with large hair-follicles. These also extend to the middle line of the sac both above and below the anus, and there is an aggregation of larger pores lodged in a depression just above the orifice of the gland on each side. As in the male, this depression lies in the crease of skin formed when the superior part of the sac closes over the inferior part when the tail is lowered. There appears to be no definite storage-sac beneath this cluster of follicles, and, as in the female *Ariela fasciata*, the only reservoirs for secretion are those of the pair of anal glands proper.

The only other genus which requires particular mention in this connection is *Helogale*. In the male and the female of the species identified as *Helogale undulata* (text-fig. 10, A, B, C) the anal sac is well developed and provided with supplementary pouches. The anus itself lies in the centre of a slight depression defined above by a fine but distinct cutaneous ridge. On each

* By *Crossarchus* Mivart meant the species referred in this paper to *Crossarchus obscurus*, which he erroneously believed to have multiple anal glands, and *Ariela fasciata*, in which many anal glands had been described by Chatin.

side of the depression there is a small supplementary pouch a little higher up than the anus. In the middle line of the sac, nearly midway between the anus and the root of the tail, there is a moderately large unpaired supplementary pouch, and on each side of this, but a little lower down and about half-way between the anus and the margin of the sac, there is another moderately large pouch. The orifices of the anal glands open just below these in a line with the anus, but outside the central depression in which the anus lies. Thus the anal sac of *Helogale* approaches that of *Suricata*, and differs from the sac of any species of *Mungos* I have examined.

Function of the Anal Sac.

On the material at my disposal I was unable to substantiate a higher grade of development of the anal sac and its associated glands in the male than in the female, or *vice versa*. On the evidence, therefore, this composite glandular structure cannot be included in the category of sexual organs except on the plea that the secretions may help the sexes to find each other.

Captive Mongooses have the habit, also observed in Genets and Civets, of rubbing the glandular surface against the walls or projecting angles in their cage or against the legs of chairs and tables in a dwelling-room. Hence it may be inferred that one of the functions of the secretion is to make the animal's surroundings smell of itself, and the scent so applied serves, I believe, the purpose of familiarising the Mongoose with every square yard of its environment, so that, independently of vision, if need be, it can find its way with precision over any road it has once travelled*.

Several of the Mongooses, too, like *Cynictis*, *Suricata*, *Ariela*, and *Helogale* are gregarious†; and of one species of *Helogale* at least the habit of hunting in packs has been recorded. One of the larger Indian species of Mongoose (*M. vitticollis*)‡ has been seen combining in pairs in pursuit of prey. And since specialised cutaneous glands very often attain exceptional development in gregarious animals for the purpose, presumably, of helping individuals to keep together, it is not improbable that the secretion of the glandular anal sac has a functional significance in that respect in some of the Mongooses.

Finally, Hodgson's record§ that the secretion of the paired anal glands in *Mungos urva* is "aqueous, horribly fetid, and projectile to a great distance by the living animal," suggests that

* It is well known that most mammals have the habit of keeping to definite beaten tracks. The advantage of this to species like rats and rabbits is very evident. I have frequently seen rats escape from dogs by knowing exactly the position of a pipe or of a hole in a wire-net fence. They make a bee-line for the spot at full speed, and, apparently without ever seeing the hole, go straight through it, knowing the precise direction to take by complete familiarity with the track, owing, I believe, to the scent it holds.

† See W. L. Sclater, 'Fauna of S. Africa': Mammalia, vol. i. p. 69, 1900.

‡ Quoted by Blanford, 'Fauna of Brit. India': Mammalia, p. 129.

§ Journ. As. Soc. Bengal, vi. pt. ii. p. 563, 1837; also my paper in Ann. Mag. Nat. Hist. (8) viii. p. 756, 1911.

this species at least makes use of the secretion in the same way as the Skunk. I have never seen this species alive, and have never noticed any Mongoose practise the habit; but I have seen the secretion of a dead Marsh-Mongoose (*A. paludinosus*) issue, under pressure of the gland, in a narrow jet as if propelled by a squirt; and since Mr. W. L. Sclater states that this animal is able to diffuse a strong odour described as "sweet-sickening" from its anal glands, I suspect it is endowed with the same power as *M. urva*. To me the scent of the secretion in *A. paludinosus* is very nauseous.

The External Genitalia.

In the male the glans penis is always short and smooth, and emerges close in front of the scrotum as in the Felidæ and *Nandinia*. The orifice of the urethra is apparently always a large and elongated slit opening in the middle of the underside of the glans and not at its tip. The glans is laterally compressed, usually much longer than wide, attenuated towards the apex, and carries a bone or "baculum" which reaches the tip. In *Suricata*, however, it is markedly piriform and considerably expanded proximally, so that its width nearly equals its length (text-fig. 9, G, H, I, K).

The vulva is only a short distance below, or in front of, the inferior edge of the anal sac. The naked area is sometimes broadly continuous with that of the sac, as in *Bdeogale puisa* (text-fig. 9, F), sometimes connected with it by a narrow naked tract, as in *Ariela fasciata* and *Crossarchus obscurus* (text-fig. 10, G), or separated therefrom by a narrow tract of hair, as in *Helogale undulata* (text-fig. 10, A).

In the female of *Suricata* Mivart drew attention to the presence of a perineal swelling just below the anal sac, and compared it to a small scrotum (text-fig. 10, H). A somewhat similar swelling is present in the female of *Mungos smithii* I examined. This swelling occupies the position of the perfume-gland of the Civets and Genets. Since Mivart did not dissect the swelling in *Suricata*, it may be recorded that it appears to consist of fatty and not of glandular tissue. It is, in my opinion, exactly comparable to the scrotum-like excrescence so often noticed in female Hyænas and to the apparently similar structure observed by Lönnberg* in a female *Cryptoprocta*. Since the Mongooses resemble the Hyænas and *Cryptoprocta* in possessing a large anal sac, and have been compared with them in other respects, the remarkable differences in the structure of the penis in the three groups must be borne in mind. In the Hyænas (and *Proteles*) this organ is very long, fleshy, pendulous, and the glans is short and boneless. In *Cryptoprocta* the glans is exceedingly long, copiously armed with strong spicules, provided with a long bone, and emerges a long way in front of the scrotum.

* Bih. Svensk. Vet.-Akad. Handl. xxviii. Afd. iv. no. 3, 1902.

12. Notes on the Sitatunga or Marsh Antelope of the Sesse Islands, Lake Victoria Nyanza. By Major R. MEINERTZHAGEN, F.Z.S.

[Received January 14, 1916 : Read April 4, 1916.]

(Text-figures 1 & 2.)

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BUGALLA ISLAND.

The southern end of Bugalla, the main island of the Sesse Group, was visited on the 21st, 22nd, and 23rd October, 1915. In all seven mature buck were examined in the flesh, whilst twenty-two mature buck and over fifty other buck, females and young, were observed, some at very close quarters. The animals were found to be so plentiful at one spot, that as many as twelve warrantable buck, nine females, and five young were seen from one anthill.

Colour, etc.—Old males appear typical of mainland specimens ; a few white flecks and occasionally an obsolete stripe can be observed on the flank. Skin black and inclined to be hairless between the horns. Hair very thin on the under parts, long and coarse on the back.

Adult females were seen to be both dark brown and red, the latter colour predominating in the proportion of seven to one. Red females invariably had red young. Brown females were never seen with young, and they may be old ones past bearing.

All young seen were red, with white spots and flecks on the flanks and hind quarters. Solitary young were often observed lying in the open and away from their mothers. This is probably accounted for by the complete absence of any natural enemies on the island.

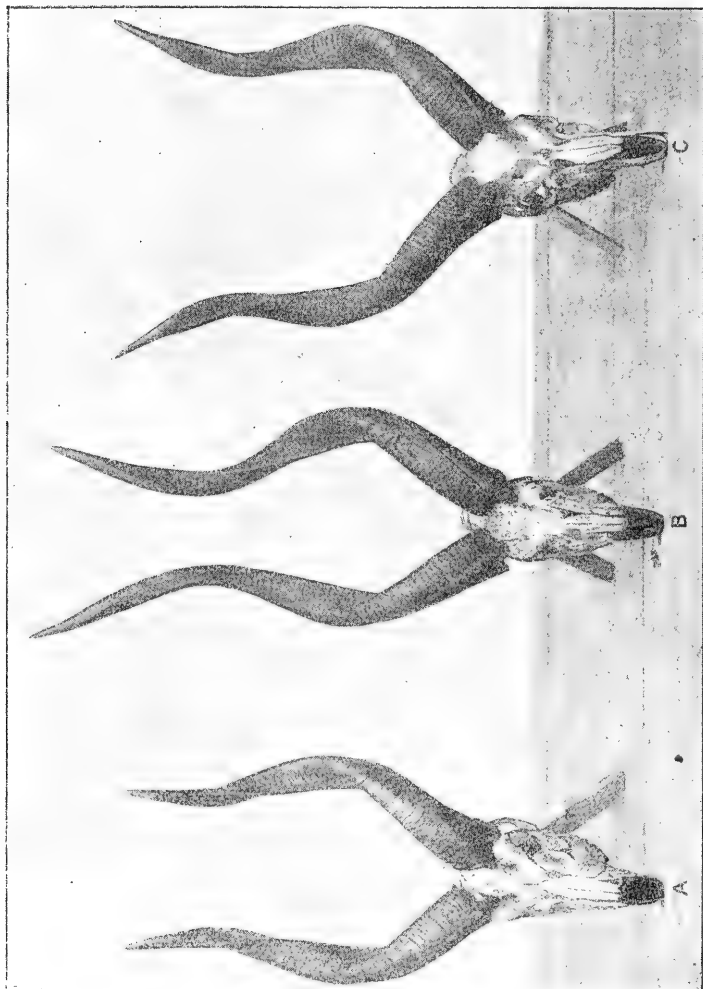
Skin very greasy. On placing a freshly shot buck in the water, a film of oil floated to the surface.

Skull and horns.—The amount of white at the tips of the horns depends on the age of the animal. It seems that the horns of very old buck tend to lose altogether the white tips, which are invariably present in younger individuals. Old buck wear their horns to a considerable degree by rubbing them on trees and anthills. This exposes the yellow under surface of the horn and adds considerably to its beauty.

The shape of the horns (text-fig. 1) is different from the usual

mainland type, having a wider splay. In specimens from the mainland the horns do not usually diverge to any great extent, the tips, however, nearly always showing a tendency to splay out considerably, whereas in the Bugalla type the tips splay out

Text-figure 1.



Photograph of the skull and horns of (A) Nkose, (B) Entebbe, an exaggerated type, (C) Bugalla Sitatunga.

but slightly. Whether this type is constant or not on Bugalla Island, I cannot say, but I never saw a "mainland" or "Nkose" type on Bugalla Island, neither did I see a "mainland" or "Bugalla" type on Nkose Island.

The skull, horn, and body measurements (in inches) of Bugalla and Nkose Sitatunga are as follows:—

No.	Locality.	Sex.	HORNS.			Skull length.	BODY.			
			Length of curve.	Girth at base.	Tip to tip.		Height.	Length less tail.	Tail.	Weight.
A.	Bugalla.	♂	24 ⁵ / ₈	7 ⁵ / ₈	16 ¹⁵ / ₁₆	11 ¹ / ₄	35 ¹ / ₂	59 ¹ / ₂	8 ¹ / ₂	204 lbs.
B.	Bugalla.	♂	22 ¹¹ / ₁₆	7 ¹ / ₂	11 ⁷ / ₈	11 ³ / ₈	36	61	9	175
C.	Bugalla.	♂	23 ⁵ / ₈	7 ³ / ₄	14 ³ / ₈	11 ¹ / ₂	35	61 ¹ / ₂	8 ¹ / ₂	196
D.	Bugalla.	♂	24	7 ¹ / ₄	17 ³ / ₈	11 ¹ / ₄	36	62	8 ³ / ₄	200
E.	Bugalla.	♂	23	...	...	...	34 ¹ / ₂	62	9	190
F.	Nkose...	♂	22 ¹ / ₄	7 ⁵ / ₈	7 ³ / ₈	11 ¹⁵ / ₁₆	39	65	9 ¹ / ₄	226
G.	Nkose...	♂	23 ¹ / ₄	7 ⁵ / ₈	6 ³ / ₄	11 ⁷ / ₈	37 ¹ / ₂	65	9	212

NOTE.—The only mainland skull I have been able to measure is that of an adult male shot at Entebbe, which measured 10·52 inches.

Feet.—An indiarubber-like pad stretches for 2³/₈ inches from the heel of the main hoof, with a small patch of short bristly hairs 1¹/₄ inches from the heel (text-fig. 2 A.).

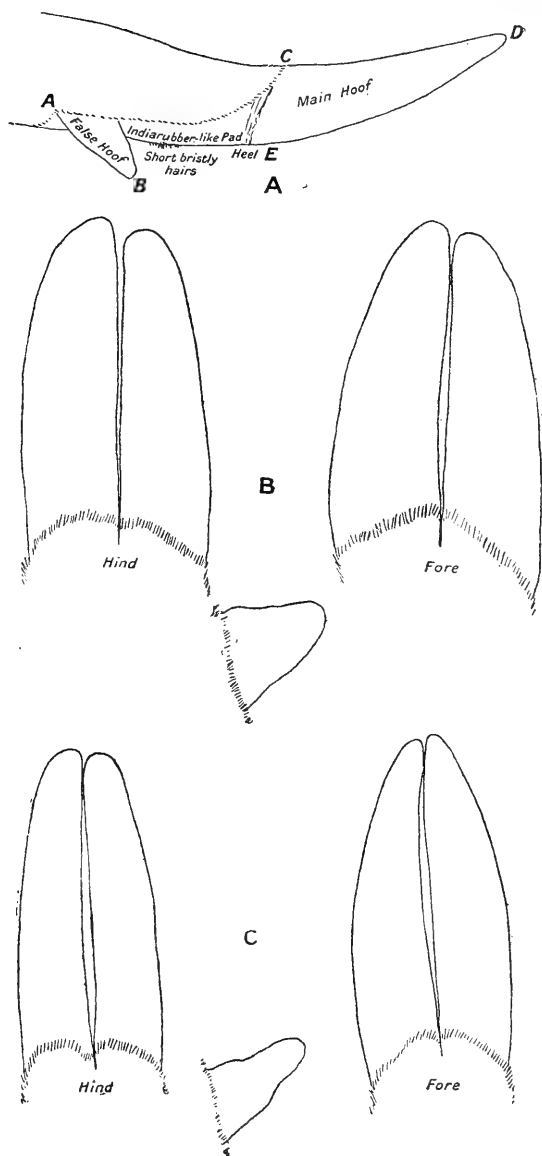
The feet splay considerably, and the hoofs can easily be moved up and down in a freshly killed specimen, so that they form an angle of about 50°. The late Captain R. B. Woosnam told me he suspected that when walking in swamps, they catch hold of stalks of weeds and papyrus to assist in progression, and this appears quite possible.

The feet measurements (in inches) are as follows:—

Specimen.	Sex.	Locality.	Hoofs, Fore and Hind.	A-D*, straight.	A-B, straight.	C-E, straight.	C-D, on curve.	Width at E across base.
A.....	♂	Bugalla.	{ F. H.	6 ¹ / ₁₆ 6 ³ / ₁₆	1 ¹ / ₈ 1 ¹ / ₁₆	1·41 1·28	3 3 ¹ / ₁₆	1·75 1·61
B.....	♂	Bugalla.	{ F. H.	6 ¹ / ₈ 6 ¹ / ₄	1 1 ¹ / ₁₆	1·39 1·27	3 3	1·73 1·59
C.....	♂	Bugalla.	{ F. H.	6 ³ / ₈ 6 ³ / ₈	1 ¹ / ₈ 1 ¹ / ₁₆	1·43 1·29	3 3 ¹ / ₁₆	1·78 1·63
D.....	♂	Bugalla.	{ F. H.	6 ¹ / ₄ 6 ³ / ₈	1 ¹ / ₈ 1 ¹ / ₈	1·37 1·27	3 3 ¹ / ₈	1·75 1·62
E.....	♂	Bugalla.	{ F. H.	6 ³ / ₈ 6 ¹ / ₈	1 ³ / ₁₆ 1 ¹ / ₁₆	1·38 1·28	3 ¹ / ₁₆ 3 ¹ / ₈	1·76 1·63
F.....	♂	Nkose.	{ F. H.	6 ¹ / ₄ 6 ¹ / ₂	1 1	1·68 1·62	2 ⁷ / ₈ 2 ¹⁵ / ₁₆	2·32 2·09
G.....	♂	Nkose.	{ F. H.	6 ¹ / ₂ 6 ¹ / ₂	1 1 ¹ / ₁₆	1·71 1·63	2 ⁷ / ₈ 2 ⁷ / ₈	2·34 2·17

* For explanation of these letters see text-fig. 2 A.

Text-figure 2.



- A. Diagram of foot of the Bugalla Sitatunga, for use with tables of measurements on pp. 377, 381.
 B. Hoof and false hoof of the Nkose Sitatunga, one-half natural size.
 C. Hoof and false hoof of the Bugalla Sitatunga, one-half natural size.

Habits.—These Sitatunga appear to have developed the habits of Waterbuck, living in the forest in the heat of the day and coming boldly into open grass-land at other times. At about 5.30 P.M. they come out and walk straight away from the forest, not hanging about the edge as Bushbuck do. Most animals return to the forest about 8.30 A.M., though some were seen still feeding on the open grass at 10.30 A.M. In the forest they lie up in the densest thickets, but once in the open they appear to be almost fearless. The firing of a rifle within 200 yards of grazing animals did not always induce them to seek cover. Though the human smell was always noted with suspicion, it was not always treated with alarm.

The majority of the animals seen were on the edge of the forest which grows along the shores of the island, but several were observed among the reeds on the lake edge, and among bush on the very tops of the grass-covered hills.

These Sitatunga are both browsers and grazers. They are particularly fond of feeding along the edge of the forest, and on two occasions buck were seen on their hind legs like goats, browsing off forest shrubs. The stomachs of three buck examined contained grass, leaves, and a little bark.

When alarmed the noise is a deep grunt, and I was unable to distinguish between that made by the two sexes.

A slow stately walk seems to be the usual mode of progression. I never saw one trot. When they make off they go clumsily, dragging their hind legs with the slightest suggestion of a kangaroo's gait. Their action when running or walking is very high. They are very averse to facing a hill, either up or down, and one buck, which I compelled to gallop down a steep hill, tripped over himself twice and completed the journey most clumsily, but much to his own alarm, for not content with barking and grunting at every bump he took on his downward journey, he continued loudly to advertise his concern for nearly half an hour later.

It will probably be found that this Bugalla type of Sitatunga is entitled to subspecific rank, but not having had the opportunity of examining mainland specimens, no further remarks will be made on this point.

NKOSE ISLAND.

Nkose Island, the southernmost of the Sesse Group, was visited on the afternoon of the 23rd October, 1915. It is about 2000 yards long and 300 broad. Throughout its entire length it is covered with dense forest, which overhangs the water's edge. There is practically no undergrowth, but the tangled mass of roots, creepers, and fallen trees makes progression difficult and affords dense cover for the Sitatunga, which appear to lie up in the thickest parts during the daytime. At the southern extremity of the island there is about an acre of short grass.

In all I saw twelve warrantable buck and numberless females and immature specimens. I killed one buck, and the rest of the party killed an adult buck, an immature buck, and captured a female and young, about a month old. I had exceptional opportunities for close observation, for sitting by a game-path I actually stroked several beasts as they walked slowly past me.

These Sitatunga differ remarkably from the Bugalla type. Their colour, length of skull, type of horn, greater size and weight, and different shape of feet appear to entitle them to sub-specific rank, and I propose the name of *Limnotragus spekei sylvestris* for this island form.

Colour, etc.—The adult male is of a uniform dull mouse-colour, and not a dark brown. The legs have no sign of reddish marks. There is no light mark on either the throat or under side of the neck. The hair is thicker than in Bugalla specimens, and the skin can seldom be seen through it, except on the under parts. All females seen were red, no brown ones being observed. All young were bright red, the one captured being well marked with white flecks and spots on the flanks and hind quarters.

Skull and horns.—The shape of the horns is well exemplified by the photograph (text-fig. 1). The horns of all I saw were of this "bushbuck" type.

The animal is larger and heavier than the Bugalla type, as will be seen by referring to the table of measurements on p. 377; the smallest Nkose skull is $\frac{3}{8}$ inch longer than the largest Bugalla skull.

Feet.—The hoofs are, perhaps, the most distinguishing feature, and this is well exemplified by text-fig. 2. The length of the hoofs differs but slightly from that of Bugalla specimens, but they are much stouter and stronger. The difference in shape of the false hoofs in the two forms is shown in text-fig. 2, B, C. Neither of the three specimens shot had the small hair-patch on the pad of indiarubber-like skin behind the hoof, whereas all the Bugalla specimens had such a small hair-patch. The feet of the young one captured were not abnormally long, in fact, no longer than one would expect to find in a young Bushbuck of his age.

Measurements of the feet are given in the table on p. 377.

Habits.—They are of necessity entirely browsers and eat a lot of bark. They live in dense dry forest, seldom seeing the light of the sun, for the small patch of open grass at the southern end of the island was particularly devoid of tracks. It is undoubtedly these peculiar surroundings which have produced such a peculiar form. Whether such a form exists or not on other such small afforested islands of the Sesse Group is not yet known. On Nkose Island there must be at least 200 individuals.

ADDITIONAL NOTE.—Since writing the above I have been able to examine three adult males shot on Nkose Island in November 1915. The skulls, horns, feet, and colour bear out what is said above, the measurements (in inches) being given below:—

Specimen.	Sex.	Locality.	Hoof, Fore and Hind.	A-D*, straight.	A-B, straight.	C-E, straight.	C-D, on curve.	Width at E across base.	Horns.			Skull length.
									Length (curve).	Girth at Base.	Tip to Tip.	
H ...	♂	Nkose.	{ F. H.	$6\frac{1}{2}$ $6\frac{3}{8}$	$1\frac{3}{8}$ $1\frac{1}{4}$	$1\cdot75$ $1\cdot69$	3 $2\frac{15}{16}$	$2\cdot29$ $2\cdot21$	21	7	10	$11\frac{15}{16}$
I ...	♂	Nkose.	{ F. H.	$6\frac{1}{4}$ $6\frac{1}{4}$	$1\frac{1}{4}$ $1\frac{1}{4}$	$1\cdot71$ $1\cdot6$	$3\frac{1}{8}$ $3\frac{1}{4}$	$2\cdot41$ $2\cdot32$	$20\frac{1}{4}$	$7\frac{1}{4}$	$5\frac{1}{2}$	12
J ...	♂	Nkose.	{ F. H.	$6\frac{1}{2}$ $6\frac{3}{8}$	$1\frac{3}{8}$ $1\frac{1}{4}$	$1\cdot69$ $1\cdot64$	$3\frac{1}{4}$ $3\frac{1}{8}$	$2\cdot36$ $2\cdot19$	$21\frac{1}{4}$	$7\frac{1}{4}$	$11\frac{1}{8}$	$12\frac{1}{8}$

* For explanation of these letters see text-fig. 2 A, p. 378.

13. An Experimental Determination of the Factors which cause Patterns to appear Conspicuous in Nature. By J. C. MOTTRAM, M.B. (Lond.)*.

[Received March 4, 1916: Read May 9, 1916.]

(Text-figures 1-20.)

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INTRODUCTION.

It is an undisputed fact that patterns often render animals inconspicuous in Nature. These patterns have definite characters on which their inconspicuousness depends, and in a previous paper (P. Z.S. 1915, p. 679) some of these characters were defined. Just as against any single background, or against any series of backgrounds, patterns can be placed which will appear inconspicuous, so other patterns can be placed which will appear relatively conspicuous. Experiments were carried out to determine the characters which render patterns conspicuous, and these are dealt with in Part I. of this paper. Having defined the factors for conspicuousness, the Indian Diurnal Lepidoptera were examined to see whether any of these insects presented patterns which must render them conspicuous. Part II. deals with this consideration.

PART I.

SCHEME OF DESCRIPTION.

Experiments were carried out with artificial patterns, against artificial backgrounds. These are described under four headings:—

- (A) The consideration of plain objects against plain backgrounds.
- (B) The consideration of patterned objects against plain backgrounds.
- (C) The consideration of plain objects against patterned backgrounds.
- (D) The consideration of patterned objects against patterned backgrounds.

The experimental conditions are shown in text-fig. 1; standard

* Communicated by the SECRETARY.

candles were used. In order to obtain a series of backgrounds ranging from dark to light tone, the object was fixed on a glass plate and was illuminated separately from the background, as shown in text-fig. 1, B; by moving the background near to or away from its illumination, and by using backgrounds of different tones, it was possible to obtain every grade of tone, from black to white.

In these experiments tone is alone considered; colour was kept constant by using only black, white, and neutral greys.

(A) *Plain Objects against Plain Backgrounds.*

Plain objects may enter into consideration of pattern, because they are in reality objects covered by a very small pattern. The visibility of plain objects was found to be affected by the following factors:—the human eye, the lighting, the atmosphere, the background, and the object.

The human eye, even when it does not present some gross defect, nevertheless is found to vary from individual to individual; so that the readings made by one person cannot be directly compared with those of others. Working with the same eye, several factors affect visibility; if the eye be allowed to become fatigued, the greatest distance at which objects can be seen is much reduced. Experiments showed that from thirty to forty observations could be made during two hours without encountering fatigue effects.

Some time must be allowed for the eye to become accommodated to a sudden change in illumination: for a change from daylight to almost complete darkness, twenty minutes is necessary; working with two standard candles, it was found that fifteen minutes must be allowed.

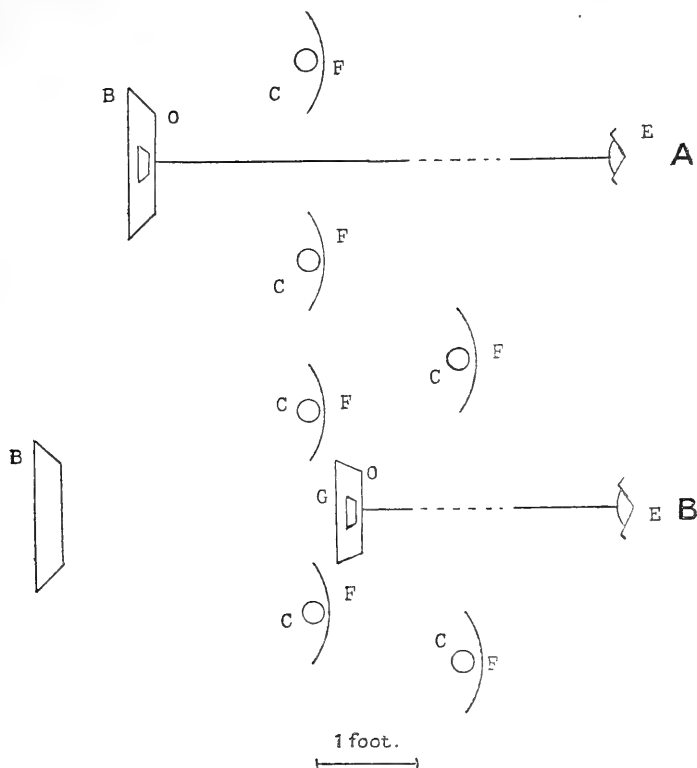
The eye was also found to vary somewhat from day to day: health and general fatigue are probably the cause of these variations. Owing to this, one cannot directly compare the reading of one day with that of another. The accuracy with which measurement can be made is indicated in experiment no. 1.

The effect of the opacity of the air on visibility does not enter into these experiments, as no measurements beyond eighty feet were made, and observations were not made during fogs.

The Effect of Lighting.—Experiments showed that the greater the illumination the greater the distance at which objects can be seen, all other factors remaining constant.

The Effect of the Background.—A plain object is visible at a great or small distance according as to whether the difference in the amount of light coming from the object and the background is great or small. A white object is more visible against a black background than against a grey one, and more visible against a dark-grey than against a light-grey one. Experiments were not carried out to define this relation more accurately; but the

Text-figure 1.



Ground plan of apparatus used for measuring visibility of objects and blending distance of patterns. A = when object and background are illuminated by the same light. B = when illuminated by different light.

c = standard candles, F = screens, E = eye, B = background, O = object, G = glass plate.

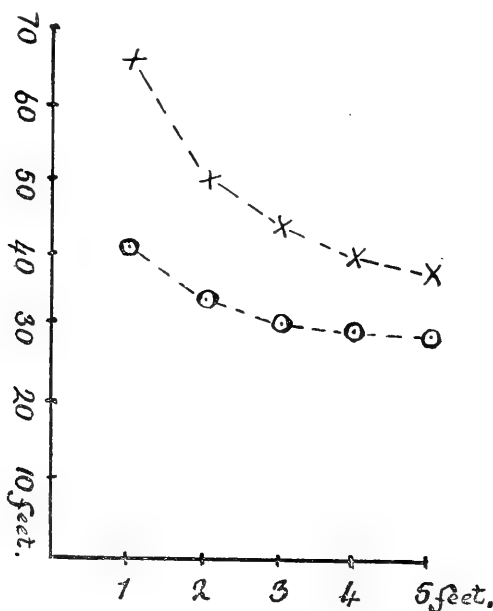
EXPERIMENT NO. 1.

- A. Candles 1 ft. apart : conditions as in text-fig. 1 : candles distant 1 ft. from glass plate on which object was placed : background of grey paper 2 ft. from glass plate. Object of black needle-paper, 36 sq. mm. The following ten readings (in feet) of the greatest distance at which the object could be seen, were made at intervals of five minutes :—72, 72·8, 72·9, 72·8, 74·4, 73·4, 74·1, 73·5, 72·7, 72·9.
- B. Candles 1 ft. apart : patterns 2 ft. 1 in. from candles : pattern consists of alternate black and white squares, 25 sq. mm. : pattern covered, 16 sq. cm. The following ten readings (in feet) of the distance at which the pattern blended into an even grey tone, were made at intervals of five minutes :—31, 33, 33·6, 34·1, 34, 33·9, 34·5, 33·7, 33·8, 34·3, 34.

following experiment (no. 2) was made as it has a bearing on the relative visibility of patterns, as will appear later. It shows

that a constant-in-tone contrast between object and background does not result in a constant visibility.

Text-figure 2.



Relative visibility of objects.

Ordinates = distance at which object is visible.

Abscissæ = distance of candles from object.

X = white object against black background.

O = black object against white background.

EXPERIMENT No. 2.

Experimental conditions as in text-fig. 1. Candles 1 ft. apart.

Materials:—Backgrounds: white, of white Bristol board 100 sq. cm.; black, of black needle-paper 100 sq. cm. Objects:—White, of white Bristol board 4.5 sq. cm.; black, of black needle-paper 4.5 sq. cm.

Results (mean of three observations).

When distance from candles to object was	white square was visible against black background at	black square was visible against white background at
1 foot	66.5 feet	41.6 feet
2 feet	50.4 "	34.4 "
3 "	44.1 "	32.2 "
4 "	40.9 "	31 "
5 "	37.2 "	30.7 "

This experiment shows that a white object on a black back-

ground is more visible than a black object on a white ground. It can be seen (text-fig. 2) that the higher the illumination the greater the difference; at low illuminations the curves of visibility approach one another (they would meet at complete darkness). The same was found to be the case when object and background were of different shades of grey, instead of black and white. The light-grey object against the dark-grey background is more visible than the dark-grey object against the light background.

It was thought that the lower visibility of the black object on the white ground might be due to the dazzling effect of the large area of white. It was found that reduction in the area of the white background by means of black diaphragms produced the opposite effect, and, further, that the nearer the diaphragm was brought to the object the less visible the object became. It was further found that when the white square on the black background was similarly surrounded by white diaphragms, the same effect resulted (see experiment no. 3).

EXPERIMENT No. 3.

Experimental conditions as in text-fig. 1. Candles 1 ft. 6 ins. apart;
distance of candles from object, 2 ft.

Materials:—Backgrounds of white Bristol board and black needle-paper, 100 sq. cm.
Objects of same materials, 4.5 sq. cm. Black and white square diaphragms,
total size 100 sq. cm., with a central square hole:

No. 1.	Size of central hole was	64	sq. cm.
" 2.	"	36	"
" 3.	"	16	"
" 4.	"	4	"
" 5.	"	1	"
" 6.	"	0.16	"

White object on black background was visible at 45.5 feet.

When surmounted by No. 1 white diaphragm, at 40.7 "

"	"	2	"	37.6	"
"	"	3	"	34.8	"
"	"	4	"	29.5	"
"	"	5	"	24.0	"
"	"	6	"	13.4	"

Black object on white background was visible at 38.4 feet.

When surmounted by No. 1 black diaphragm, at 32.2 "

"	"	2	"	30.5	"
"	"	3	"	30	"
"	"	4	"	29.6	"
"	"	5	"	21.7	"
"	"	6	"	15.5	"

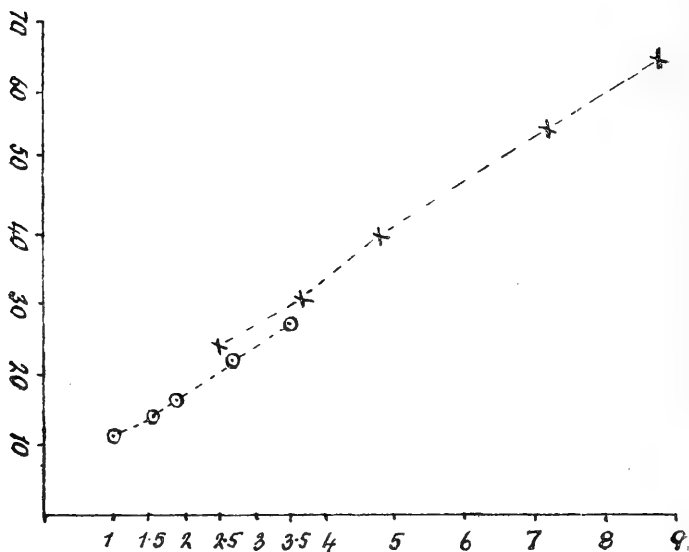
(Above readings are the mean of three observations.)

It would thus appear that light tone on dark is more visible than dark on light. This has been considered to be due to the eye recognising the object, in one case by a positive image, in the other by the absence of stimulation. This fact is of considerable importance in regard to the visibility of animals in Nature: those exhibiting large areas of light tone must

be considered to be, other things being equal, much more conspicuous than those which do not. For instance, a light-coloured butterfly flying across a meadow, or down a hedgerow, is visible at a much greater distance than a dark one.

This greater visibility of light-toned objects in Nature can easily be demonstrated by comparing the visibility of black and white discs against a great number of natural backgrounds: only against snow and certain parts of the sky is the white the less visible; against the vast majority of backgrounds the white is very much more visible.

Text-figure 3.



Visibility of objects in proportion to size.

Ordinates = distance (in feet) at which object is visible.

Abscissæ = size of object, in square millimetres.

EXPERIMENT No. 4.

Experimental conditions as in text-fig. 1. Candles 1 ft. apart and 2 ft. from object.

Materials:—Black and white backgrounds of Bristol board and black needle-paper.

Objects:—Black needle-paper of the following sizes: 2.5, 3.7, 4.8, 7.2, and 8.8 sq. mm.; and white paper of the following sizes: 1, 1.6, 1.9, 2.8, and 3.5 sq. mm.

The above diagram shows the distance at which the black objects were visible against the white background (X) and at which the white objects were visible against the black background (O).

An even more convincing way of demonstrating this fact is to take a series of artificial backgrounds, from white, through grey,

to black: find the background against which black and white are equally visible under some natural condition of lighting—for instance, in a wood; now compare this background with

Text-figure 4.

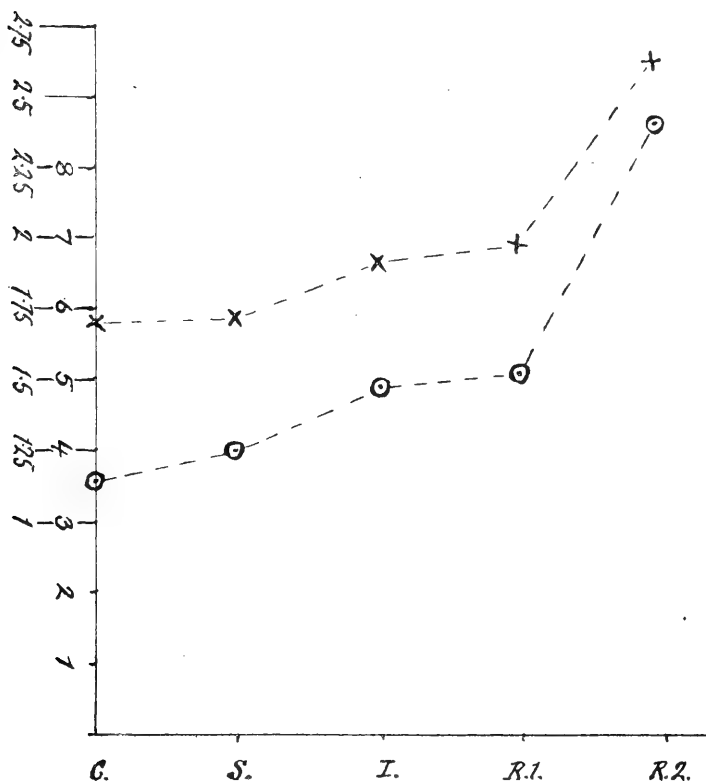


Diagram showing the correspondence between the visibility of objects of different shapes (circle, square, isosceles triangle, and rectangles) and the concentration of their areas.

EXPERIMENT No. 5.

Candles 1 ft. apart; objects distant from candles 1 ft. 6 ins.

Objects of black needle-paper, area 16 sq. mm.; background of white Bristol board.

Objects.	Distance at which visible, in feet.	Inverse figures.
Circle	59	170
Square	58	173
Isosceles triangle of 90° ...	53	190
Rectangle, 8×2	51	198
Rectangle, 16×1	38	263

(Mean of five readings to nearest whole number.)

	$\frac{\text{Circumference}}{\text{Area}}$
Circle	$\frac{2\sqrt{\pi x}}{x^2} = \frac{3.56}{x}$
Square	$\frac{4x}{x^2} = \frac{4}{x}$
Isosceles triangle of 90°	$\frac{(2+2\sqrt{2})x}{x^2} = \frac{4.83}{x}$
Rectangle, $2 \times \frac{1}{2}$	$\frac{5x}{x^2} = \frac{5}{x}$
Rectangle, $4 \times \frac{1}{4}$	$\frac{8.5x}{x^2} = \frac{8.5}{x}$

In text-fig. 4 the inverse visibility figures (X) are conventionally plotted with the numerator of the periphery over area (⊙). It can be seen that the visibility curve closely follows the concentration of area curve.

the surrounding natural backgrounds: it will be found that it is very much lighter in tone than the lightest natural background which can be found in the wood.

On referring to the diagram (text-fig. 2, p. 386) it can be seen that the difference in visibility between white and black is greater at high illumination than at low. It follows that at night white is, in Nature, not nearly so conspicuous with regard to black as it is during daylight.

Diurnal animals presenting a large area of white or light tone must therefore be considered to be much more conspicuous than nocturnal animals similarly patterned.

The Effect of the Object's Characters on Visibility.—The characters, size, and shape will affect the visibility of an object when all other factors are kept constant. When the contrast in tone between object and background is great (the object being light in tone and the background dark), the human eye is able to define an object subtending an angle of approximately one minute. Distinction must be made between the ability to define or focus, and that to see: the eye cannot define a star, although it may be able to see it.

Keeping the shape of the object constant, experiments show that visibility is directly proportional to size: the larger the object, the greater the distance at which it is visible.

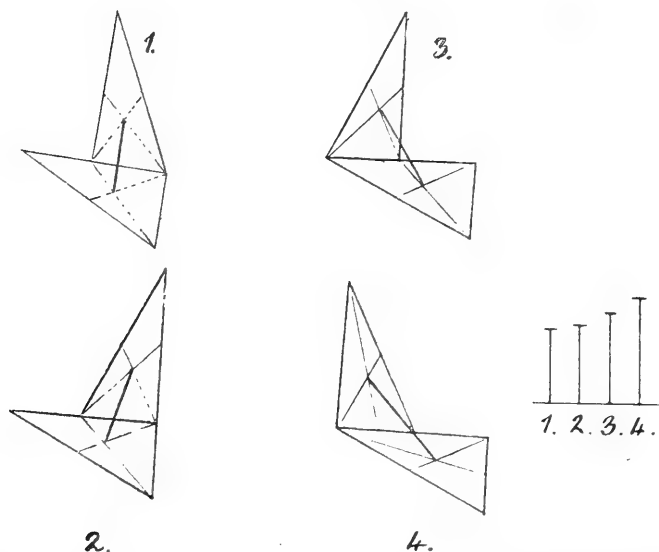
Whether the relation between size and visibility is the same for all shapes has not been determined; though during the course of this and other investigations a large number of shapes have been examined, no exceptions have been noted.

The visibility of objects is dependent upon their shape. Circles, squares, triangles, and rectangles of the same area are not equally visible. Experiments show that the more concentrated the area the greater the visibility.

In the following experiments concentration is measured by the ratio of circumference over area, and it can be seen that the distance at which the object is visible is inversely proportionate to this ratio (see experiment no. 5).

As a circle is the most concentrated form that an object can have, therefore it is the most visible form. The ratio circumference over area only gives the concentration for simple figures. Objects can be made of the same area and of the same circumference but of different concentration. In these cases concentration must be represented by the moment of area round the centre of area.

Text-figure 5.



Four figures of the same area and of the same circumference but which are not equally visible. The concentration of their areas is estimated by the length of the cord joining the centre of area of the two triangles.

EXPERIMENT No. 6.

Candles 1 ft. apart. Objects distant from candles 2 ft. 1 in.

Objects of black needle-paper, of the same area and having the same circumference, composed of two triangles as shown in the figure; the longest side measured 1.1 cm., the shortest .5 cm., and the angle opposite the longest side was a right angle. Background of white paper.

Object.	Distance at which visible.
No. 1	51 feet.
„ 2	50 „
„ 3	47 „
„ 4	45.5 „

(Mean of six observations.)

The figure shows the lengths of the cords joining the centres of areas of the two triangles; it can be seen that when the cord is short and the area therefore concentrated, then the visibility is great, and *vice versa*.

In experiment no. 6 mathematical expressions are avoided by presenting the concentration as the length of a cord. Areas of the same size and circumference, but of different concentration, are dealt with in this experiment; and the same conclusion is arrived at, namely, that the more concentrated the area of the object the greater its visibility.

This completes the consideration of plain objects against plain backgrounds. The following facts have been observed:—

1. The greater the difference in the amount of light coming from an object and background, the greater the distance at which the object is visible.
2. A constant contrast in tone between object and background does not ensure a constant visibility. Dark objects against light backgrounds are less visible than light objects against dark backgrounds. This difference is greater at high illuminations than at low ones.
3. The larger the size of the object, and the greater the concentration of its area, the greater the distance at which it is visible.

It follows that a plain object will appear conspicuous against a plain background when the contrast in tone between object and background is great, and when the object is lighter rather than darker in tone than the background, and when its size is great and area concentrated.

(B) *Patterned Objects against a Plain Background.*

As long as the pattern of an object against a plain background is visible, the object must be visible. It follows that visibility will to some extent depend upon the blending distance of the pattern.

The following factors were found to affect the blending distance of patterns: lighting, contrast in tone between the components of the pattern, size of the components and shape of the components, and the relative size of the components.

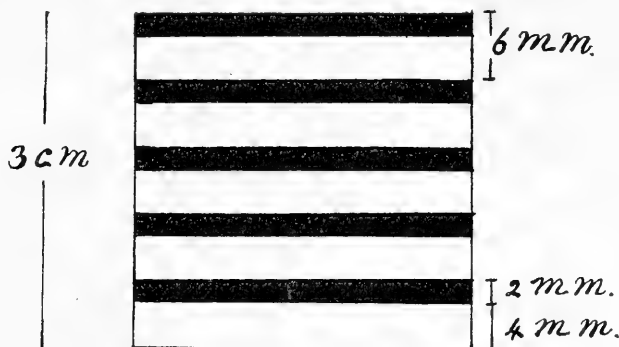
1. *Lighting*.—Experiments showed that the better the illumination the greater the distance at which the pattern was visible. A pattern which by day appears conspicuous, on account of the long distance at which it can be seen, at night may be difficult to see (*e. g.*, the Zebra).

2. *Contrast in Tone between the Components*.—The greater the contrast, the greater the blending distance of the pattern. A chequered pattern of black and white is visible at a greater distance than one composed of two shades of grey.

3. *Size of Components*.—The larger the components the greater the blending distance, all other factors remaining constant, as was shown in my previous paper (*loc. cit.*). If there be components of more than one size, then the smaller will blend first and the larger at a greater distance.

4. *Relative Size of the Components.*—For any given pattern there is a particular proportion of the components which gives the greatest blending distance.

Text-figure 6.



A specimen of the patterns used in Experiment No. 7.

EXPERIMENT No. 7.

Candles 1 ft. 6 ins. apart. Objects 2 ft. 2 ins. from candles.]

Background grey. Objects square, 9 sq. cm. in size, divided horizontally into five black and white stripes of 6 mm. (see text-fig. 6).

In No. 1 there is 2/8 black and 6/8 white	Pattern blends at
" 2 " 3/8 " 5/8 "	24 feet 2 inches.
" 3 " 4/8 " 4/8 "	26 " 11 "
" 4 " 5/8 " 3/8 "	26 " 9 "
" 5 " 6/8 " 2/8 "	25 " 9 "

A striped pattern is dealt with in the above summary; it shows that where the amount of black to white, or white to black, is very small, the blending distance is smaller than when there are about equal amounts of the two components.

Referring also to experiment no. 9 (p. 397), it can be seen that for the types of patterns here dealt with there is similarly a particular proportion of black to white which gives the greatest blending distance under the experimental conditions.

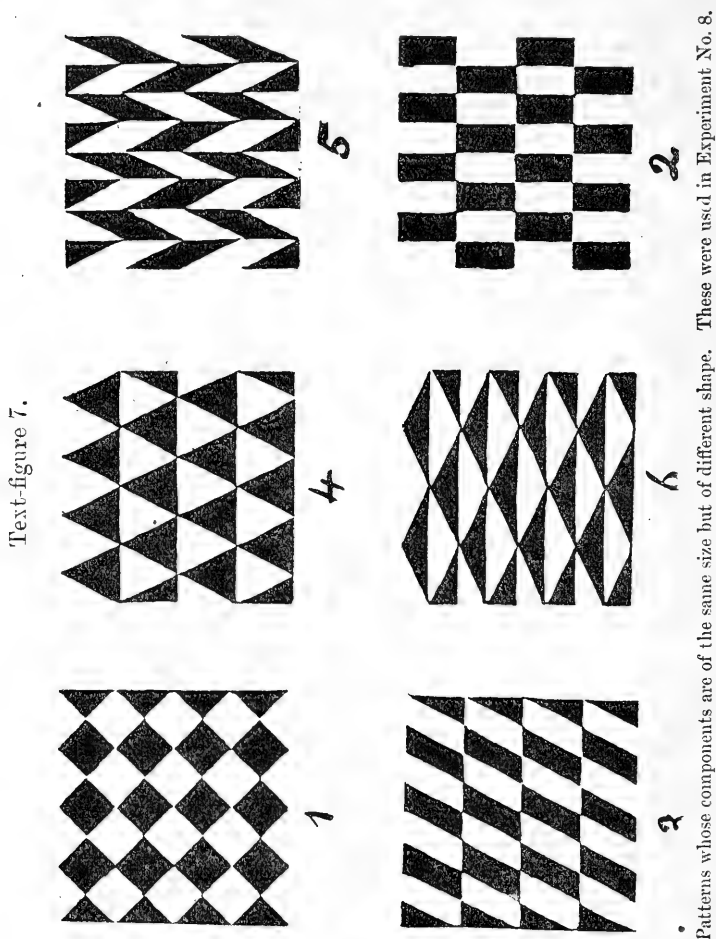
5. *Shape of the Components.*—It has been shown that the visibility of plain objects depends upon the concentrations of their areas. Experiments show that, similarly, the blending distance of patterns is proportional to the concentration of the components of the patterns: the more concentrated the components, the greater is the blending distance, as is seen in the following experiment.

EXPERIMENT No. 8.

The blending distance of black and white patterns, of which the components are of the same size but of different shape. Experimental conditions: Candles 11 ins. apart, and 2 ft. from glass plate on which patterns were fixed.

Background behind glass plate, of grey paper, at such a distance that it is of the

same tone as the patterns after they have blended. Text-fig. 7 shows the patterns used. The following table gives the length of the circumference of the component and the blending distance :—



Pattern.	Length of circumference of component.	Blending distance.
No. 1	28·3 mm.	48 feet.
" 2	30 "	47·5 "
" 3	32·5 "	43 "
" 4	32·5 "	43 "
" 5	42·5 "	40 "
" 6	42·5 "	40·5 "

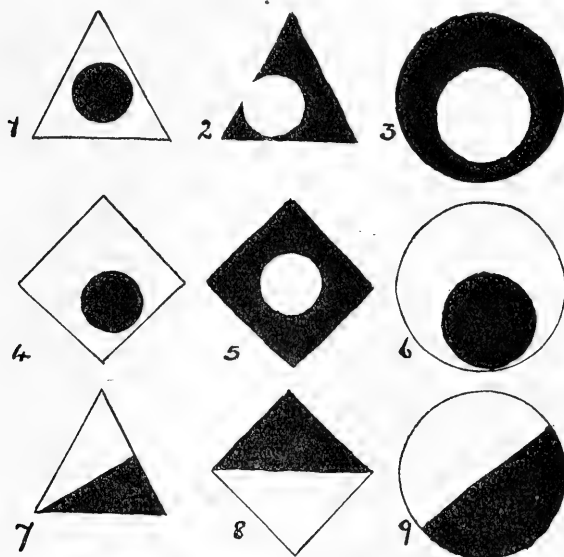
(Mean of six observations.)

The experiment shows that the smaller the circumference of the component, and therefore the greater its concentration, the greater the blending distance of the pattern.

With plain objects the circle is the most visible shape which they can have; so with patterns, the circle gives rise to the greatest blending distance.

Patterns composed of only two components require special consideration, as they have an important bearing on the subject of conspicuous patterns, as will appear later. It has been seen that the larger the pattern the greater the blending distance; it follows that, in order to give an object a pattern which will blend at the greatest distance, only two components must be used, thus making it as large as possible. To further increase the blending distance the relative tones of the two components must be as far removed as possible, and at least one of the components must have as concentrated an area as possible.

Text-figure 8.



1-6. Patterns in which one component has the most concentrated shape, namely a circle, and is surrounded by the other component. 7-9. Patterns in which neither component has the most concentrated shape.

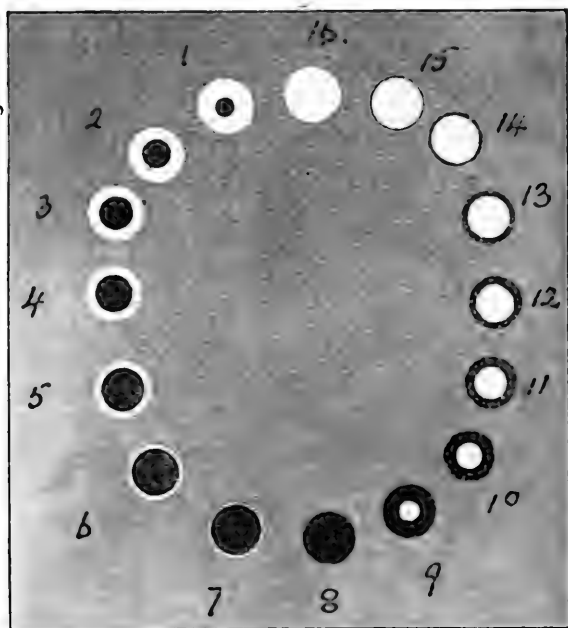
If the object be a triangle, a square, or a circle, then these conditions would be fulfilled in figs. 1-6 of text-fig. 8. These patterns would blend at a greater distance than would those shown in figs. 7-9.

It has been seen that a third factor affects the blending distance, namely, the relative proportion of the components.

If a series of circular objects be made, as in text-fig. 9, and be

examined against a number of differently-toned backgrounds, it will be found that the blending distances are not the same for different backgrounds. If, for instance, they be examined against a white background, then in the case of nos. 1-7 no pattern-blending occurs: the objects appear as black spots. If, instead, the background be light grey, then the white blends

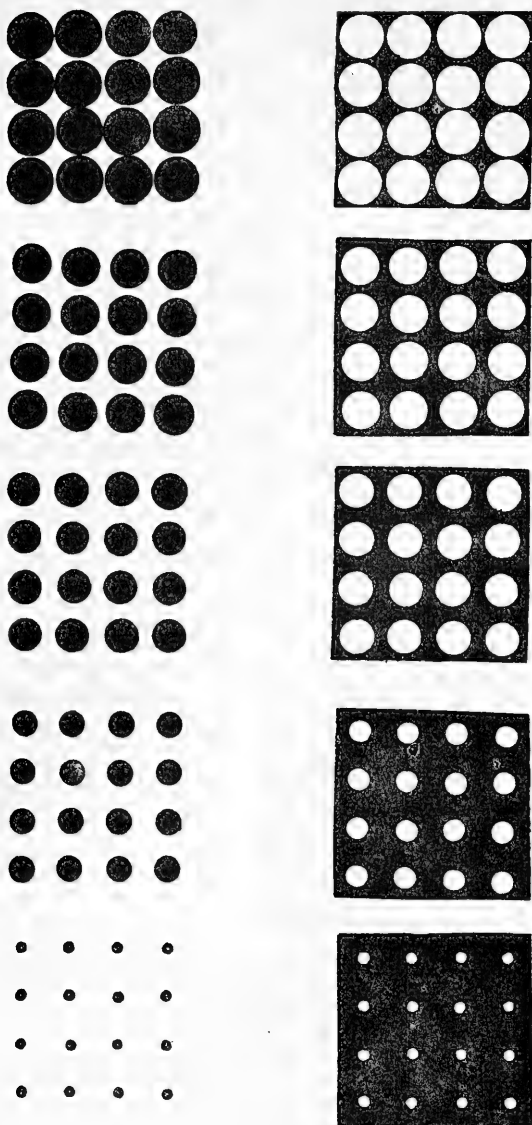
Text-figure 9.



A series of eye-spot patterns used in the experiment described on p. 401, and set out in Table I. The uppermost disc is white, the lowest black. The others contain from above down $\frac{7}{8}$, $\frac{6}{8}$, $\frac{5}{8}$, $\frac{4}{8}$, $\frac{3}{8}$, and $\frac{2}{8}$ th of white, either concentrated in the centre, or in a ring round the periphery.

with the background and leaves the central black area visible after the white has ceased to be distinguishable from the background. This difficulty can be overcome by joining up a number of two-component patterns, and then finding the blending distance; this has been done in the following experiment.

Text-figure 10.



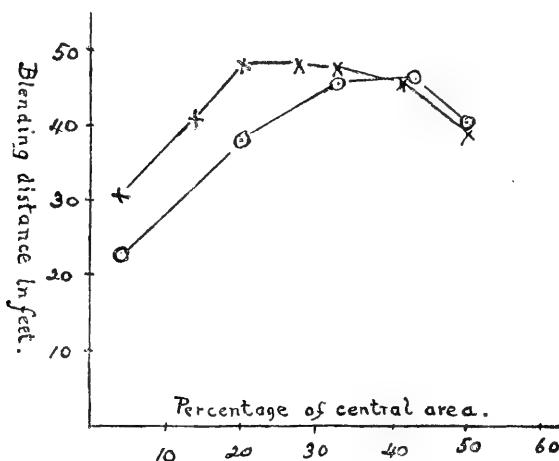
Portion of a series of spotted patterns used in Experiment No. 9.

EXPERIMENT NO. 9.

The blending distance of black and white spotted patterns, as shown in above figure. The percentage of white to black varied from 10 to 60 per cent. Experimental conditions: Candles 1 ft. 6 ins. apart and 2 ft. 6 ins. distant from the pattern, which was placed on a glass plate with a grey background behind, as in experiment no. 8.

The following diagram (text-fig. 11) shows the blending distance in feet, plotted against the percentage of the spots to the whole pattern; the X shows the white-spot pattern, and the O the black centre. It can be seen that the white spot shows the greatest blending distance, which occurs when the white is approximately 20 per cent. of the whole.

Text-figure 11



Ordinates=blending distance of the patterns in feet. Abscissæ=percentage of the central components of the pattern. O=the readings obtained when a black centre pattern was used (text-fig. 10, upper series). X=when a white centre pattern was used (text-fig. 10, lower series).

It can be seen that the greatest blending distance is produced by a white-centre pattern containing 20 per cent. of white, and it is shown also that the white-centre pattern blends at a greater distance than the black centre. It appears, therefore, that the blending distance of patterns is affected in the following ways:—

- (1) By contrast in tone between the components: the greater the contrast, the greater the blending distance.
- (2) By size of components: the larger the size, the greater the blending distance.
- (3) By shape of components: the more concentrated the area of the components, the greater the blending distance.

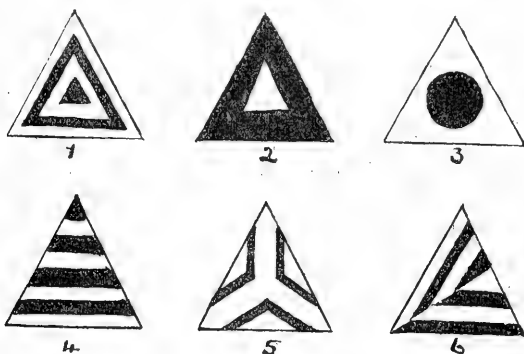
In order, therefore, to cover an object with a pattern which will blend at the greatest distance: (1) make the tone of the components a great contrast, black and white; (2) make the size of the components as large as possible, by reducing their number to two; (3) make the shape of the components as concentrated as possible, by making one of them a circle.

The consideration of the visibility of patterned objects against plain backgrounds can now be resumed. As before mentioned, a patterned object is visible as long as its pattern is visible; it follows that objects whose patterns blend at a great distance are more conspicuous than those whose patterns blend at a short distance.

There remains to be considered patterned objects which are visible against plain backgrounds after the pattern has blended at distance.

In a previous paper it was shown that, as regards visibility (as measured by the greatest distance at which the object is visible), patterned objects against plain backgrounds are neither more nor less visible than plain ones. It was also shown that, where the pattern interrupts the margin, the outline of the object appears blurred and difficult to define after the pattern has blended at

Text-figure 12.



1-3. Patterns which do not interrupt the margins of the object. 4-6. Patterns which interrupt two sides, three sides, and one side of the object.

distance. It follows that a further condition must be fulfilled in order that a patterned object may be as conspicuous as possible against a plain background: the pattern must present an uninterrupted margin, for example, as shown in text-fig. 12, 1-3. If these patterns be viewed from beyond their blending distance, they will appear more defined than nos. 4, 5, and 6, in which the pattern interrupts the margin. Apart from this, the visibility of patterned objects beyond the blending distance and against plain backgrounds is similar to that of plain objects against plain backgrounds. A patterned object can be made more conspicuous against a series of plain backgrounds than can a plain object, because, though a plain object can be made very visible against a single plain background by a strong contrast in tone with the

background, nevertheless, when a series of backgrounds are used, then the object will appear inconspicuous against those similar in tone. On the other hand, with a patterned object, when the background is similar in tone to one of the components, then the other will make a strong contrast and cause the object to be easily visible.

It has been seen that the greatest blending distance which a pattern can have is one in which the white or lighter component is concentrated in the form of a circle, and that an object is most conspicuous against a wide series of backgrounds when it presents a pattern of only two components. Experiments were therefore made to discover which of two component patterns, the light-centre one or the dark, is the more conspicuous against a wide series of backgrounds. A series of discs were made, as shown in text-fig. 9, and examined against a series of backgrounds in the following manner :—

Text-fig. 1, B (p. 385) gives a ground-plan of the experimental conditions ; it can be seen that the backgrounds are illuminated separately from the discs, which are fixed to a glass plate. By moving the backgrounds towards or away from the light, a continuous and wide range of tone in the background can be obtained. First, the background of white paper was moved so as to exactly match in tone that of the white in the discs. Under these conditions the all-white disc was invisible ; of the rest, the disc with a white centre, $\frac{7}{8}$ of the whole, was found to be the least visible, and next the disc with $\frac{6}{8}$ white centre. The most visible disc was the all black.

The discs were examined in a similar manner over a wide series, and in each case the three least visible discs and the most visible were noted ; the following table gives the results.

It can be seen that, except against backgrounds lighter than the white in the discs, the black-centre eye-spots are less visible than the white, and the appearances of the discs as seen from a distance show that the white-centre discs are the more visible.

The greater visibility of the white-centre eye-spots is especially marked when the backgrounds approach the dark end of the series ; and as, as already shown, the backgrounds in Nature are, for the most part, of dark tone, it follows that white-centre eye-spot patterns of two components must be more conspicuous than black-centre patterns. Similarly, the white-centre pattern must be more visible than any other combination of black and white, because in this pattern the white is most concentrated, and therefore has the greatest visibility and the longest blending distance. It follows that against a series of plain backgrounds, and especially a series of relatively dark tone, the white-centre eye-spot pattern is the most visible one that an object can have.

TABLE I.

Backgrounds.	The three least visible discs.	The most visible disc.
White paper 1 ft. 3 ins. behind the discs gives a background considerably lighter than white of discs.	White, 7/8 white, 6/8 white.	Black disc.
White paper 1 ft. 3 ins. behind the discs gives a background lighter than white of discs.	White, 7/8 white, 6/8 white.	Black disc.
White paper 2 ft. behind the discs gives a background of the same tone as the white of the discs.	White, 7/8 white, 6/8 white.	Black.
White paper at 2 ft. 3 ins. gives a background a little darker than white of discs.	1/8 black, 7/8 white, white.	1/8 white.
White paper at 2 ft. 6 ins. behind the discs	1/8 black, 2/8 black, 5/8 white.	2/8 white.
White paper at 2 ft. 9 ins.	2/8 black, 3/8 black, 4/8 white.	1/8 white.
White paper at 3 ft. gives a background against which black and white are equally visible.	4/8 black, 5/8 black, 2/8 white.	Black and white discs.
White paper at 3 ft. 6 ins., or a grey paper at 1 ft. 11 ins., giving the same-toned background.	5/8 black, 4/8 black, 2/8 white.	7/8 white.
Grey paper at 2 ft. 6 ins.	5/8 black, 4/8 black, 1/8 white.	7/8 white.
Grey paper at 3 ft. 6 ins.	6/8 black, 7/8 black, 2/8 white.	6/8 white.
Grey paper at 5 ft.	7/8 black, black, 6/8 black.	7/8 white.
Grey paper at 5 ft. 6 ins. gives a background of the same tone as black of discs.	Black, 7/8 black, 6/8 black.	White disc.
Grey paper at 6 ft. 6 ins. gives a background darker in tone than the black of the discs.	Black, 7/8 black, 6/8 black.	White disc.

The most conspicuous pattern that an object can have against a series of plain backgrounds may now be defined :—

- (1) The pattern must consist of two components.
- (2) The components must differ widely in tone (black and white).
- (3) The lighter component (white) must be concentrated at the centre in the form of a circle.
- (4) The darker component must surround the white so that nowhere is there an interrupted margin.
- (5) If the series of backgrounds be of low tone (as they are in Nature) then there must be more white than black in the pattern.

(C) *Plain Objects against Patterned Backgrounds.*

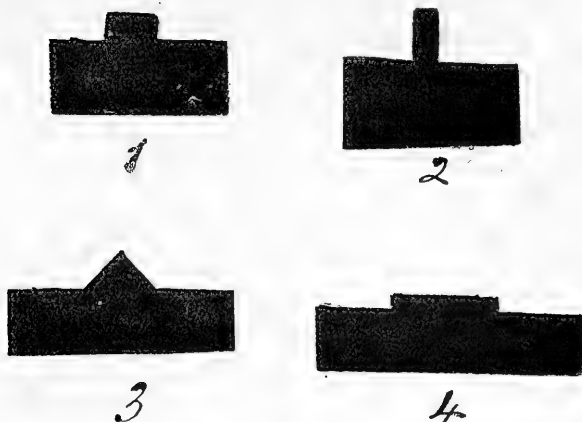
(1) If the object is visible after the pattern has blended at distance, then the factors which control its visibility are the same as those of plain objects against plain backgrounds. The outline of the object will, however, appear blurred just as when a patterned object, whose pattern is interrupted at the margin, appears blurred when viewed against a plain background. The conclusions are similar, the only difference being, that in one case the object is plain and the background patterned, whereas in the other the object is patterned and the background plain.

(2) If the object becomes invisible before the pattern of the background blends at distance, then the object may be seen against one component of the background; in which case the factors controlling visibility will be similar as are those of plain objects against plain backgrounds, except that the near presence of an area of different tone will affect the visibility of the object. A black square on the white component of a checkered background will be less visible than on a plain white background (see experiments, nos. 2 & 3). With this exception, the factors controlling visibility are similar to those of a plain object against a plain background. The object may be visible against two or more components of the background. If the object is of the same tone as one of the background components, then the object will appear as a projection from the margin of one component.

Experiments were carried out to discover whether the factors controlling visibility were different from those of a black object against a white background, and it was found that, except for the decrease in visibility due to the presence of an area of black (in this case touching the object), the visibility was similar to that of a plain object on a plain background, except that the effect of shape of the object was rather different from its effect when dealing with plain objects against plain backgrounds, as seen in the following experiment*.

* This consideration has an important bearing on concealment by indented or scalloped margins; a series of experiments has been carried out from this point of view which, however, are only of present interest in so far as they show that an even margin is a factor for conspicuousness.

Text-figure 13



Objects of the same size but of different shape lying at the junction of a black and white background as used in Experiment No. 10.

EXPERIMENT No. 10.

The visibility of black objects projecting from the margin of a large black mass. The objects are all of the same size but of different shape, as shown in the text-figure.

Experimental conditions: Candles 1 ft. 3 ins. apart and 3 ft. 6 ins. from objects.

Object no. 1	visible at	57 feet.
" "	2	54 "
" "	3	49.5 "
" "	4	32 "

Compare with Experiment No. 5.

The object may be visible against two or more components of a patterned background, and may be different in tone from either component.

Text-figure 14.



1. A grey disc placed over the junction of a black and white background. If the disc approaches in tone more nearly the white of the background than the black then from a distance it will be seen as in no. 2; if more nearly the black, then as in no. 3.

If a grey disc be placed over a black and white junction, as in text-fig. 14, and be viewed from gradually increasing distances,

a point will be reached at which one half of the disc is blended with one component of the background, whilst the other half is seen as projecting into the other component. If the grey disc more nearly approaches the black in tone than the white, then at a distance it will appear as in text-fig. 14, 3; if it more nearly approach the white, then as no. 2.

The following experiment illustrates this appearance :—

EXPERIMENT No. 11.

Candles 1 ft. apart and 2 ft. distant from background.
Background half black and half white (7 × 5 ins.).

Objects circular, 20·4 sq. mm., eight in number and ranging in tone from black to white. Objects placed exactly over the junction of the black and white of the background.

Visibility distance.

1. Black	33 feet.	}	Visible as a dark projection into the white of the background.
2. "	30 " 5 inches.		
3. Dark grey	37 " 5 "		
4. "	20 " "		
5. "	18 " 5 "	}	Visible as a light projection into the black of the background.
6. Light grey ...	23 " 5 "		
7. "	34 " 7 "		
8. White	35 " 9 "		

An object was prepared of such a grey tone that it was neither seen as a white nor as a black projection into the background's components. This object was the least visible disc and visible at 16 ft. 4 ins.

Some similar experiments were carried out with backgrounds composed of different tones of grey instead of black and white, and it was found that the objects likewise appeared as projectors into one or other of the components, according as to whether the object more nearly approached in tone one or other of the components.

If, for instance, the background was made of two dark grey tones, then only the darkest objects appeared as black projectors against the lighter of the two components.

As in Nature backgrounds are dark in tone rather than light, it follows that light grey or white discs will be more visible under these conditions, *i.e.*, when seen against two or more components of a patterned background, than dark discs.

As mentioned in the last experiment, there is one tone of grey against which black and white are equally visible, and when the object is of this particular tone it never appears as a projective from one component on to the other. Against backgrounds composed of tones other than black and white, there is similarly one grey tone which the object may have which will cause it to give a similar appearance.

An experiment was carried out with discs of this tone to discover whether the effect of size of the object was similar or not to that found when dealing with plain objects against plain backgrounds. As seen in the following experiment, the effect is similar :—

EXPERIMENT No. 12.

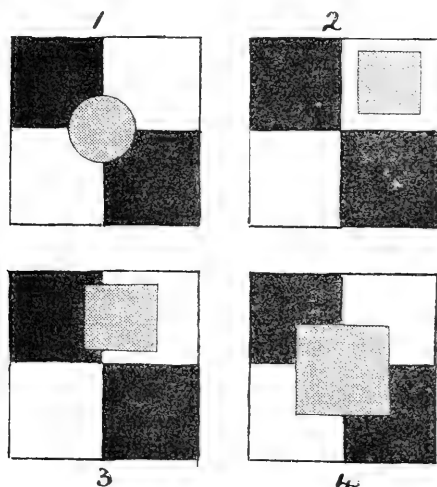
Candles 1 ft. apart and distant 2 ft. from background.
Background as in Experiment No. 11.

Objects of various sizes were made of grey discs of such a tone that they were seen neither as black nor as white projections into the components of the background. These objects were placed over the junction of the black and white components of the background. The following table gives the visibility of the discs:—

Size of grey disc.	Distance at which visible.
41·9 sq. mm.	27 feet 5 inches.
30·2 "	24 " 2 "
20·4 "	19 " 5 "
6·1 "	9 " 1 "

The effect of shape was found to be different, as in the case of objects of the same tone as one of the components of the background. (See experiment no. 10.)

Text-figure 15.



Objects placed on more than two components.

A few observations were made with objects placed in front of more than two components, as in text-fig. 15, 1 & 4, but no special difference was noted from those when only two components were covered by the object.

Another arrangement of an object against a patterned background remains to be mentioned. The object may more or less resemble, both in tone, in shape, and in position, one of the components of the background; in this case, though it may appear to be invisible on account of this similarity and thus to come under a separate category, nevertheless this is not so,

as it will fall naturally under one of the conditions already considered. For instance, a very light grey object may resemble the light square of the checkered background, both in shape, size, and position, as in text-fig. 15, 2; but it can also be considered under the heading "Objects falling on one component of the background." If it falls as in text-fig. 15, 3, then on two components of background; if as in no. 4, then as an object visible after the pattern has blended at distance.

It appears, therefore, that a direct resemblance does not necessitate a separate consideration.

Conclusions.—The factors which make for the conspicuousness of plain objects against patterned backgrounds appear to be similar to those when plain backgrounds are used. If the pattern of the background interrupts the object's margin, then outline blurring occurs. The near presence, or contact with the object, of an area of tone similar to the object makes it less visible.

(D) *Patterned Objects against Patterned Backgrounds.*

If a patterned object be viewed against a patterned background from gradually increasing distances, several different appearances may be seen.

(1) The pattern of the object may blend before the pattern of the background, in which case it will appear as a plain object against a patterned background.

(2) The pattern of the background may blend before the pattern of the object. The object will then appear as a patterned one against a plain background.

(3) The patterns of object and background may both blend and yet the object may still be visible against the background; in which case the object will appear plain against a plain background.

These three conditions have already been dealt with.

(4) A fourth appearance may occur. The object may not be visible, although neither its pattern nor the pattern of the background have blended.

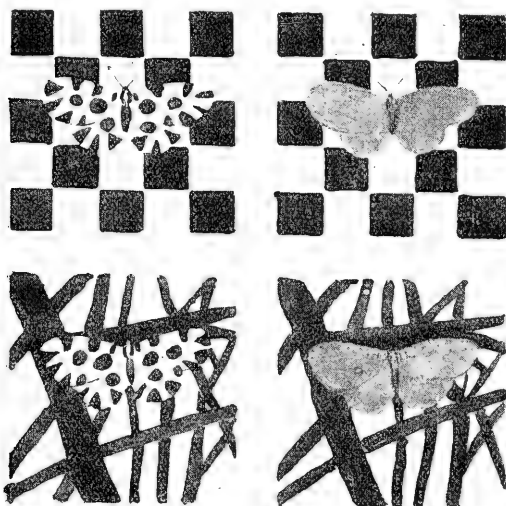
Before dealing with this appearance the first three must be briefly considered. It has already been shown in my previous paper (*loc. cit.*) that though a patterned object is not less visible than a plain one, nevertheless, if the pattern interrupts the margin, then its outline after pattern-blending appears blurred and indistinct, as compared with a plain object of the same tone as the patterned one after blending.

It has also been mentioned (p. 402) that outline blurring similarly occurs when the object is plain and the background patterned. It might therefore be concluded that against patterned backgrounds the outline of a plain object would appear just as blurred as that of a patterned one beyond the blending distance of the background's pattern; but when both the object's

pattern and the background's pattern are blended, and provided that both interrupt the junction of object and background, then the blurring effect of these two interruptions are added, and cause the junction of object and background to appear much more indistinct than when only one pattern interrupts.

In text-fig. 16, if in each case the insects remain visible after the patterns are blended, then the outline of the patterned one will be the more indistinct when the tone of the patterned insect after pattern-blending is the same as that of the plain insect.

Text-figure 16.



Visibility of insects on different backgrounds.

It follows that animals with a pattern which interrupts the margin will be less visible than plain animals against a patterned background as well as against a plain one; and further, that against a patterned background an uninterrupted margin will be as necessary for conspicuousness as against plain backgrounds; in fact, experiments appeared to show that it was more necessary, because the blurring effect of the background pattern required to be counteracted.

In Nature, a pattern which interrupts the margin must be a great aid to concealment against patterned backgrounds, because the backgrounds are irregular and the animal must often be seen with one or more of its margins against a single component of the background, as shown in text-fig. 16.

The conclusions as regards conspicuousness which have already been made must thus apply to patterned objects against

patterned backgrounds. There remains to be examined only the fourth condition, in which the object cannot be seen though both the object's and the background's patterns remain visible. This invisibility is due to a great similarity between the patterns of object and background in size, shape, and relative tone of the components. It is obvious that the most conspicuous pattern will be inconspicuous against a background made of a similar, or closely similar, pattern. For this reason, under these special conditions, it is not possible to define a pattern which will be especially conspicuous, unless the pattern of the background is also defined.

It may be concluded, therefore, that the pattern which has been called the white centre eye-spot pattern is a most conspicuous one against every background with the exception of backgrounds themselves composed of eye-spot patterns. It follows that in Nature the white eye-spot pattern must be very conspicuous, provided that this type of pattern is not continuously found as a background.

White centre eye-spot patterns in Nature.—Natural backgrounds were examined in order to discover whether this type of pattern was to be found and to what extent, and it was at once noticed that they were very uncommon; a morning's foray amongst woods, fields, hedgerows, and broken country resulted in only a few examples. It is not difficult to make such patterns artificially out of doors; for instance, by laying round white stones on circular patches of dark moss, by placing shining leaves over dark rough ones, by viewing pierced leaves against the light, and in many other ways. Natural eye-spot patterns may be conveniently described under the following headings:—

1. *On bare ground.*—(a) Due to irregularities of the surface. Working with plasticene the pattern can be produced by a shallow conical pit with a flat bottom, by a truncated cone lying on its base, or by a cylinder standing in the middle of a cylindrical depression; in each case top lighting is necessary. Viewed from above, a light centre dark-margin circular pattern is seen; the pattern does not perfectly reproduce the one desired, because the centre instead of being lighter in tone than the background is either of the same tone or somewhat darker. It is evident that by artificial methods this pattern can only be reproduced with difficulty, and thus its occurrence in Nature must be very rare. By prolonged search isolated examples are to be seen.

(b) Due to the surface being of broken tones; a light stone or one reflecting the light from the sky when lying on a circular dark patch will give rise to the pattern. Examples of this nature are not difficult to find, but they are never numerous and always isolated.

2. *On grass and other short vegetation.*—Except for flowers, which are considered elsewhere, the eye-spot pattern is very rarely seen; occasionally light reflected from a shiny leaf supplies an example.

3. *Rank vegetation*.—Light from a shiny leaf, or a leaf in strong light against shadow, occasionally forms the pattern.

4. *Scrub, hedgerows, and wood margins*.—Circular leaves in very strong light against dark shadows often give rise to a pattern which is somewhat like a white centre eye-spot one, but distinction must be made between a pattern consisting of light spots on a dark background and the pattern under consideration. The first is common in Nature; the second requires a light centre, a dull margin, and a background of a different tone. Occasionally this arrangement is to be seen among vegetation, but only isolated examples are to be found.

5. *Light woods*.—Here are sometimes to be seen patterns similar to those described under the previous heading. Where sunlight penetrates through foliage and falls on dark ground or foliage beneath, white spots of light result, and when these happen to fall on dark objects they produce the white centre eye-spot pattern. According to the frequency with which they happen to fall on dark objects is the prevalence of the pattern. When the ground beneath the trees is much broken in tone, several may be seen from a single station. Several conditions are, however, necessary for their production—an uncovered more or less vertical sun, a not completely dense canopy of foliage, and a broken ground beneath.

6. *Heavy woods*.—If the foliage be not too dense the pattern may be produced as described in no. 5.

7. *Sky*.—On looking up at the sky through foliage, white spots are to be seen in the intervals between the leaves and where there are holes in them. If a white spot happens to be surrounded by a dark shadow or a deep-toned leaf, then a white-centre dark-margin eye-spot results. A small number of these are always to be seen. It may be pointed out that though man is not accustomed to view foliage in this way, many animals of low stature and whose eyes are set looking upwards as well as forwards must frequently take this view.

8. *Water*.—Very small pools of water when they reflect the sky and when, as is often the case, they are surrounded by a ring of moist and therefore dark-toned ground, have the appearance of the eye-spot pattern. Foliage overhanging water or floating upon it also rarely gives rise to the same pattern, the sky reflected from the water forming the white centre and the foliage the dark ring. Drops of water and dew under some conditions of lighting give rise to an abundance of the pattern of a transitory nature.

9. *Flowers*.—By far the most common examples in Nature of the eye-spot pattern are to be found in flowers. A dark centre eye-spot is as common as a light centre. There can hardly be a doubt that flowers are purposely conspicuous; it is therefore noteworthy that their patterns conform to the rules which experiments have decided must be followed in order that a pattern may be conspicuous in Nature.

Flowers are, as a rule, circular ; their patterns consist of seldom more than two components, one being concentrated in the middle in the form of a circle, and there is usually a strong contrast in tone (and colour) between the two components.

It might be thought that these arrangements of pattern in flowers were due to convenience of growth ; but the eccentric shapes and patterns assumed where special animals are sought for the purpose of fertilisation indicate that flowers are not forced by growth to assume the circular shape and eye-spot pattern.

In conclusion it may be said that, except in the case of flowers, white-centre dark-margin eye-spot patterns are rarely to be seen in Nature and are almost always isolated. Sunlight penetrating through foliage on to broken ground and sky views through foliage are the two most common causes. As regards flowers, eye-spot patterns are very common, but the centre is as often darker than the margin as *vice versa*.

It follows that animals presenting this type of pattern must be considered to be conspicuous in Nature.

PART II.

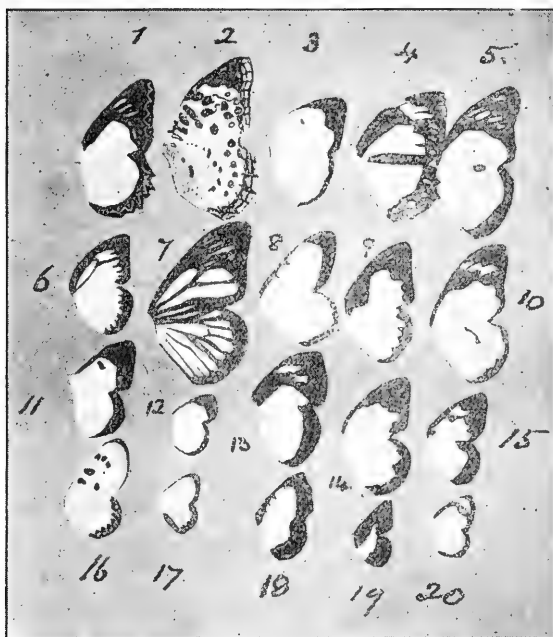
Having by experimental methods defined the types of pattern which render an object conspicuous, attention was turned to the animal kingdom to discover whether examples of these types could be found and, if present, what was their distribution. Search was made among the Lepidoptera because their wings offer a plain, flat patterned surface, and thus the complicating factor of solidity is avoided. Rather than search through a large amount of material, it was decided to deal thoroughly with a definite amount, viz., the Indian Lepidoptera. Moore's 'Lepidoptera Indica' was the work chosen, because of its good coloured illustrations of each species. On glancing through these plates several types of pattern were found which previous consideration showed would render these insects conspicuous. The first type to be dealt with is shown in text-fig. 17. It can be seen that the pattern consists of a central white, or light yellow, area surrounded by a black margin, so that the four wings combined present an irregular, white-centred, black-margined pattern. The margin of the wings is, except in two cases (nos. 1 and 4), not scalloped. The black marginal band is sometimes broken by small spots or bands of light tone, but only in the case of no. 2 is the margin interrupted by pattern.

This type of pattern presents, therefore, those characters which previous consideration has shown must render the insect conspicuous in Nature: the table on p. 412 gives its distribution among genera of the Indian Lepidoptera.

Salatura (text-fig. 17, 7) and *Acidalia* (no. 2) do not conform to the type in several respects. In *Salatura* the centre white

area is broken up by dark bands, and in *Acidalia* by black spots, besides which there is a half-tone area at the centre of the wings. They are introduced for several reasons, as will appear later. Certain butterflies are presumed to be protected from the attack of enemies by ill-flavour; further, it has been noted that these insects are conspicuous in Nature (and it has been suggested that they are conspicuous in order to warn enemies); and lastly, it has been noted that the pattern and coloration of these insects are

Text-figure 17.



Types of all the genera illustrated in 'Lepidoptera Indica' which present patterns of the first type under consideration.

1. *Cethosia*. 2. *Acidalia*. 3. *Catopsilia*. 4. *Elymnias*. 5. *Apatura*. 6. *Appias* & *Huphina*. 7. *Salatura*. 8. *Pareba*. 9. *Catophaga*. 10. *Limnas*. 11. *Eurymus*. 12. *Kibireta*, *Nirmula*, & *Terias*. 13. *Ixias*. 14. *Hyposcirtia*. 15. *Anaphæis*. 16. *Telchinia*. 17. *Chrysophanus*. 18. *Stiboges*. 19. *Daimio*. 20. *Callosune*.

mimicked by insects which are not thus protected by ill-flavour, in order that they may gain protection by means of a false cloak. The pros and cons of this contention cannot be discussed here, but it is remarkable that many of the insects presenting the type of pattern under consideration belong to what are considered to be protected genera, or to what are considered to be

TABLE II.

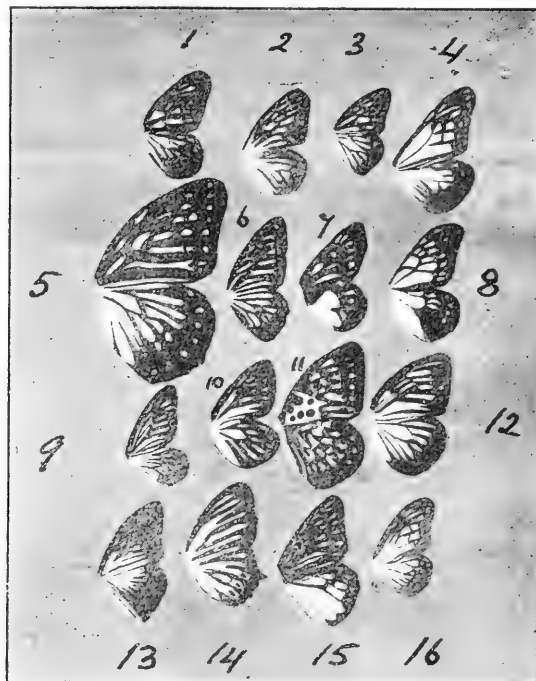
Family.	Subfamily.	Genus.	Male.	Female.	Both sexes.	Protected.	Mimicry.	Neither protected nor mimicry.
Nymphalidæ.	Euplœinæ.	<i>Linnaea</i> .....	...	...	×	×
		<i>Salatura</i> .....	...	...	×	×
	Elymninæ.	<i>Elymnias</i> .....	...	×	...	...	×
	Nymphalinæ.	<i>Apatura</i> .....	...	×	...	...	×
	Argynninæ.	<i>Cethosia</i> .....	...	...	×	×
		<i>Acidalia</i> .....	...	×	...	...	×
Riodinidæ.	Nemeobiinæ.	<i>Pareba</i> .....	...	...	×	×
		<i>Telchinia</i> .....	...	...	×	×
Pieridæ.	Pierinæ.	<i>Stiboges</i> .....	...	...	×	...	...	×
		<i>Anaphæis</i> .....	...	...	×	...	...	×
		<i>Appias</i> .....	...	...	×	...	...	×
		<i>Hypophina</i> .....	...	...	×	...	...	×
		<i>Hypocritia</i> .....	...	...	×	...	...	×
		<i>Catophaga</i> .....	...	...	×	...	...	×
	Coliinæ.	<i>Kibbreeta</i> .....	...	...	×	...	...	×
		<i>Nirmula</i> .....	...	...	×	...	...	×
		<i>Terias</i> .....	...	...	×	...	...	×
		<i>Catopsilia</i> .....	...	...	×	...	...	×
		<i>Ixias</i> .....	...	...	×	...	...	×
Lycænidæ.	Lycænopsinæ.	<i>Callosome</i> .....	...	...	×	...	...	×
		<i>Eurymus</i> .....	×	...	...	...	...	×
Hesperiidæ.	Lycænopsinæ.	<i>Castalius</i> .....	...	...	×	...	...	×
	Chrysophaninæ.	<i>Chrysophanus</i> ...	×	...	...	...	...	×
Hesperiidæ.	Celænorrhinæ.	<i>Daimio</i> .....	...	...	×	...	...	×
			×	×
5	11	24	2	3	19	5	3	16

unprotected insects mimicking protected. It can be seen that out of 24 genera forming Table II., 5 are described by Moore as protected and 3 as exhibiting mimicry; whereas out of all the 600 genera described only 41 are mentioned as either protected or mimicking. No reason can be given why the other 16 genera (for the most part belonging to the Pieridæ) present a conspicuous pattern*. It is, however, noteworthy that the sexes are alike, with the exception of *Eurymus* and *Chrysophanus*, where the pattern is confined to the male. Several of the genera are amongst the commonest of butterflies, and at certain times collect

* The Pierinæ and Coliinæ are considered by some observers to be "protected" insects.

together and migrate in immense swarms. *Salatura* was introduced into this table because it shows a considerable resemblance to the next type to be considered. The bands of dark tone crowning the central light area have been drawn too boldly and of too dark a tone, which makes the resemblance closer than it really is.

Text-figure 18.



'Types of all the genera illustrated in 'Lepidoptera Indica' which present patterns of the second type under consideration.

1. *Parhestina*. 2. *Parantica*. 3. *Orinoma*. 4. *Caduga*. 5. *Penthema*. 6. *Paranticopsis*. 7. *Delias*. 8. *Calinaga*. 9. *Cadugoides*. 10. *Caduga*. 11. *Neurosigma*. 12. *Metaporia*. 13. *Hestina*. 14. *Radena*. 15. *Prioneris*. 16. *Bahora*.

Examples of the second type of pattern which must render the insect conspicuous in Nature are shown in text-fig. 18. It can be seen that the insects present an uninterrupted margin, the pattern nowhere reaching the margin, and that at the margins there is an area of dark tone, whilst the centre of the wings is much lighter in tone. As before, there is no scalloping or irregularity of the margin. It follows that this pattern

conforms to the factors which have been considered to make for conspicuousness. Table III. shows the distribution of this second type of pattern. At a short distance the central patterned area will become blended and give rise to a light grey tone, and the insect then has an appearance similar to the type first considered. As before, it can be seen that out of 18 genera, 7 are protected and 7 mimic: in this case, therefore, the conspicuous pattern is accounted for in the case of 14 out of the 18 genera; 4 remain unaccounted for. It is noteworthy that in all cases the sexes are alike.

TABLE III.

Family.	Subfamily.	Genus.	Male.	Female.	Both sexes.	Protected.	Mimicry.	Neither protected nor mimicry.
Nymphalidæ.	Euplœinæ.	<i>Radena</i> .....	...	...	×	×
		<i>Tirumala</i> .....	...	...	×	×
		<i>Bahora</i> .....	...	...	×	×
		<i>Parantica</i> .....	...	...	×	×
		<i>Caduga</i> .....	...	...	×	×
	Satyrinæ.	<i>Orinoma</i> .....	...	...	×	...	...	×
	Elymniinæ.	<i>Melynius</i> .....	...	...	×	...	×
	Nymphalinæ.	<i>Hestina</i> .....	...	...	×	...	×
		<i>Parhestina</i> .....	...	...	×	...	×
		<i>Neurosigma</i> .....	...	...	×	...		×
		<i>Penthema</i> .....	...	...	×	...		×
	Calinaginæ.	<i>Calinaga</i> .....	...	...	×	...	×
Papilionidæ.	Papilioninæ.	<i>Cadugoides</i> .....	...	...	×	...	×
		<i>Paranticopsis</i> ...	...	...	×	...	×
Pieridæ.	Pierinæ.	<i>Metaporia</i> .....	...	...	×	×
		<i>Delias</i> .....	...	...	×	×
		<i>Prioneris</i> .....	...	...	×	...	×
	Eroniinæ.	<i>Pareronia</i> .....	...	...	×	...	...	×
3	8	18	—	—	18	7	7	4

Conspicuous pattern combined with an absence of secondary sexual dimorphism is so frequently associated with a protected species, that attention must be drawn to the fact that some of the unaccounted-for genera in both tables may be protected genera, although not mentioned as such in the work consulted.

Finally, all the insects which are mentioned by Moore as being either protected by ill-flavour or mimicked by other species, are briefly considered in order to see whether or not they present

patterns which experiments have shown must be conspicuous in Nature*.

Text-fig. 19 shows their patterns. No. 3 is like *Salatura*, a stage between the first and second types. There is, however, an absence of a defined dark margin to the hind wings, the margins are not scalloped, and the pattern does not interrupt the margin, though it approaches near to it; it thus presents some of the characters making for conspicuousness.

Text-figure 19.



Types of all the genera mentioned in 'Lepidoptera Indica' as being "protected" beyond those already given in text-figs. 17 & 18.

1. *Hestia*. 2. *Menama*. 3. *Piccarda*. 4. *Bimbisara*. 5. *Calliphaea*. 6. *Condochates* & *Neptis*. 7. *Euploea* & *Pademna*. 8. *Stictoploea*. 9. *Penoa* & *Crastia*. 10. *Cynitia*. 11. *Damisepa* (the dark tone of this insect should be darker). 12. *Isamia*. 13. *Stabrobates*. 14. *Libythea* (? protected). 15. *Eryphila*.

Nos. 2, 5, 7, 8, 9, and 12 are conspicuous in so far as they present a large, dark, unpatterned area; their margins are not scalloped or interrupted by pattern; the marginal spots, when

* Mimicry within the Papilioninae is only referred to once in an indefinite manner.

present, would, however, tend to mask the outline. As to whether or not these insects are conspicuous in Nature must depend upon the tone of the backgrounds against which they are commonly to be seen; if the backgrounds be light in tone they would be conspicuous insects, but if the insects lived in dark forests, for instance, they would not be especially conspicuous.

No. 11 is similar to the last except that both wings present a large white patch which must make the insect more conspicuous. The patch on the fore wing interrupts the anterior margin and must therefore have the opposite effect.

No. 10 presents a black-centre white-margin pattern which, as has been seen, is almost as conspicuous as the white-centre black-margin pattern.

Nos. 4, 6, 13, & 14 present patterns which do not interrupt the margin but, instead, follow it; there are three central bands or rows of spots which are surrounded by black, and the margins of the wings are not scalloped, thus several factors making for conspicuousness are present.

In no. 1 the pattern everywhere interrupts the margin, and the margin of the wing is not scalloped. The pattern is not therefore a conspicuous one, the general tone of the insect is light and the wing-expanse large; thus, in spite of an inconspicuous pattern, the insect might be conspicuous if its natural environment were of dark tone—if, for instance, it were a forest insect. It may be noted that another species of the same genus (see text-fig. 20, 4) presents a typical conspicuous pattern.

No. 15 presents no character making for conspicuousness; the margin is somewhat scalloped, the pattern interrupts the margins, the insect, as drawn, is coloured a middle brown with a darker line pattern, and is mimicked by *Rohana parisatis*. With the exception of this genus and *Hestia*, the patterns of these protected or mimicked insects all show one or more characters which make for conspicuousness, and present patterns much less perfectly conspicuous than the two types first dealt with. The first type conforms very closely to the pattern which experimental consideration indicates must be the most conspicuous. Even the larger proportion of black to white tone in the pattern conforms; as the backgrounds in Nature are for the most part dark rather than light in tone, so there should be a greater proportion of white to black in the pattern. It is not possible to show why less perfect types are to be found; perhaps they present a stage in the evolution of the conspicuous patterns, or that for some reason a more perfect pattern is not required by these insects. On referring to text-figs. 17 and 18 it can be seen that the mimicking species present patterns which are not so perfect as the models. *Acidalia*, for instance, could with justice be removed from the first series.

As a contrast to these patterns four inconspicuous patterns are shown in text-fig. 20, 1, 2, 3, 5; it can be seen that in three the margin is scalloped; in nos. 1 and 3 the pattern interrupts the

anterior and lateral margins; in no. 5 it interrupts the anterior margin. In no. 2 the pattern of eye-spots and irregular bands is confined to the outer margins of the wings, whereas the rest of the wings is of an even dull tone (brown); in nos. 1, 3, and 5 the pattern is likewise more or less confined to the margins, leaving the centre of the wings plain; in no. 1 the outer margin is fringed by outstanding scales which cause the margin to appear indistinct. Unprotected butterflies show, as a rule, one or other of these and other characters which cause their outlines to blend into their surroundings, the pattern is confined to the wing margins and it interrupts the margin, and the margin is

Text-figure 20.



Insects with inconspicuous patterns.

1. *Pontia daplidice* ♀. 2. *Anadebis himachala* ♂. 3. *Lethe neelgheriensis* ♀.
4. *Hestia hadenii* ♀. 5. *Pazala sikkima* ♀. 6. *Hestia malabarica* ♀.

scalloped. On the other hand, those insects which have been considered to present conspicuous patterns show none of these characters: their outlines are not scalloped, their patterns are not especially confined to the margin and do not interrupt the margin.

Finally, it may be said that whilst the inconspicuous pattern of insects conceals their outline, the silhouette of an insect against its surroundings (the patterns may or may not mimic the backgrounds), the conspicuous pattern accentuates the margin.

CONCLUDING REMARKS.

Many experiments and observations have shown that the patterns and coloration of animals are related to their environment; such terms as Protective Resemblance, Obliterative Shading, etc., indicate the lines of research along which knowledge has been acquired, and which is conveniently condensed in the following table by Prof. Poulton. The basis of this classification is a resemblance, or otherwise, of the animal's coloration to its natural background. Further differentiation is achieved

TABLE IV.

A. Apatetic colours = colours resembling some part of environment.

- (1) Cryptic (a) procryptic = protective resemblance.
(b) anticryptic = aggressive resemblance.
- (2) Pseudo-semantic = false signalling.
(a) pseudo-semantic = protective mimicry.
(b) pseudo-episematic = aggressive mimicry or alluring.

B. Semantic colours = signalling colours.

- (1) Aposematic = warning.
- (2) Episematic = recognition marks.

by division according to the utility or function which this resemblance, or the reverse, has. These functions have to do with the escape from enemies, the procuring of food, and recognition by members of the same and other species. It follows that the patterns of animals must be closely related to the visual perception of their enemies, their prey, and their friends. A classification from this point of view would seem, therefore, to be the most natural, and the following table was therefore prepared.

TABLE V.

Colour and Pattern.	Unrelated to the visual perception of other animals:	for the absorption of Light Rays: for the absorption of Heat Rays: Excretory products etc.	
	Related to the visual perception of other animals.	Inconspicuous to other animals:	to the eyes of enemies = protective coloration.
			to the eyes of prey = aggressive coloration.
			to the eyes of friends = ?
		Conspicuous to other animals:	to the eyes of enemies = attracting and repelling, and warning coloration.
			to the eyes of prey = to allure prey as in Mantidæ.
			to the eyes of friends = social signals, sexual signals.

If the consideration of pattern from this aspect be of value, then an experimental analysis carried out with artificial patterns and the human eye must be a sound foundation for the study of the subject, at any rate, as regards the visual perception of mammals, provided the human eye is not widely different from that of mammals as a whole. The results of this line of investigation show that patterns of animals will bear such an intense study, and indicate that many details of pattern may be of value although they have, up to the present, and on negative evidence, been considered to be unrelated to the visual perception of their own and other species.

In view of the fact that sight is a most valuable organ of perception, and therefore a most powerful weapon in the struggle for existence, it follows that a study of pattern from this point of view is likely to throw light on some of the important problems of Nature.

14. On a small Collection of Vertebrate Remains from the Har Dalam Cavern, Malta; with Note on a new species of the genus *Cygnus*. By DOROTHEA M. A. BATE, Hon.M.B.O.U.*

[Received April 14, 1916: Read May 9, 1916.]

(Text-figures 1 & 2.)

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The researches of Spratt and Leith Adams, and later those of Dr. Cooke and Mr. Tagliaferro, on the extinct fauna of the Pleistocene cave-deposits and fissures of Malta have already yielded a rich harvest. The excavations of the two former extended over a long period. Dr. Leith Adams, for instance, spent six years in the island, a great part of this time being devoted to investigating its cave and fissure deposits†. That there is still scope for yet further research is shown by a collection lately sent for examination to the British Museum (Nat. Hist.) by the Curator of the Malta Museum. This task was very kindly entrusted to the present writer by Dr. A. Smith Woodward, F.R.S.

The literature dealing with the subject is very scattered, and the records extend over a great number of years. Therefore, before making a few observations suggested by a study of this collection, it has been thought useful to workers on the palæontology of the Mediterranean Region to give as complete a list as possible of the vertebrates of which remains have been obtained from the Pleistocene of Malta. Leith Adams published a similar list in 1877‡, but this contains a record of only twenty-one species, although *Elephas falconeri* and *Myoxus carteri* are included. It is gratifying to find that this number has since been nearly doubled, although no extensive systematic excavations have been carried on.

LIST OF SPECIES.

MAMMALIA.

1. *Ursus arctos* (?) Linn.
2. *Vulpes* sp.
3. *Canis* sp. (size of *C. lupus*).
4. *Leithia melitensis* Leith Adams sp.

* Communicated by Dr. A. SMITH WOODWARD, F.R.S., V.P.Z.S.

† Nat. Hist. & Archæol. of Nile Valley and Maltese Islands, Edinburgh, 1870.

‡ Quart. Journ. Geol. Soc. vol. xxxiii. 1877, pp. 177-190.—“On gigantic land-tortoises . . . from the Ossiferous Caverns of Malta . . . together with a list of their fossil fauna.”

5. *Eliomys* sp.
6. *Arvicola amphibius* Linn.
7. „ *pratensis* Baillon.
8. *Equus* sp.
9. *Cervus dama* (?) Linn.
10. „ *elaphus* var. *barbarus* Bennet.
11. *Hippopotamus pentlandi* Meyer.
12. „ *melitensis* Forsyth Major.
13. *Elephas mnaidriensis* Leith Adams.
14. „ *melitensis* Falconer.

AVES.

15. *Strix melitensis* Lydekker.*
16. *Eutolmaëtus fasciatus* Vieill. sp.
17. *Gyps melitensis* Lydekker.†
18. *Anser* sp.
19. *Branta leucopsis* Bechst. sp.
20. „ *bernicla* Linn. sp.
21. *Cygnus falconeri* Parker.
22. „ *musicus* Bechst.
23. „ *equitum*, sp. n.
24. „ sp.
25. *Anas* sp.
26. *Marmaronetta angustirostris* Ménétr. sp.
27. *Columba melitensis* Lydekker.*
28. *Grus melitensis* Lydekker.†
29. *Otis tarda* Linn. sp.
30. *Tetrao* sp.

REPTILIA AND BATRACHIA.

31. *Testudo robusta* Leith Adams.
32. „ *spratti* Leith Adams.
33. „ *robustissima* Tagliaferro.
34. *Lutrenys europæa* Gray.
35. *Lacerta* sp.
36. Batrachia undetermined.

Besides the above, remains of several domesticated species have been recorded by Dr. Smith Woodward from the Har Dalam Cavern, from which rude pottery has also been obtained in some quantity ‡.

I have omitted from my list both *Elephas falconeri* of Busk and *Myoxus cartei* of Leith Adams. The specimens described under the former name seem hardly sufficiently distinct to be separated from *E. melitensis*, to which species they were referred by Lydekker. The same author also pointed out that

* Cat. Foss. Birds in Brit. Mus. 1891, pp. 13, 124.

† Proc. Zool. Soc. 1890, pp. 404, 408.

‡ See Ashby, Zammit & Despott in 'Man,' Jan. & Feb. 1916, vol. xvi. Nos. 1 & 2.

M. cartei was evidently a synonym of *Leithia melitensis*; he further showed that the mandibular ramus figured by Leith Adams as that of a young specimen of *Leithia* is undoubtedly that of an *Eliomys*.

The occurrence of *Arvicola amphibius* and *A. pratensis* is given on the authority of Leith Adams, and I do not know if any specimens have been preserved. It ought to be mentioned that Dr. Caruana reported having found a portion of a lower jaw of a *Hyæna* in the island of Gozo.

So far as I am aware no thorough investigation has been made of the present-day mammalian fauna of the island, but it would seem to be but poorly represented in species, for Sir John Murray enumerates the indigenous mammalia as follows:—"The rabbit, weasel, hedgehog, Norway rat, species of mice, and bats" *.

I should like to take this opportunity of recording my grateful thanks to Dr. A. Smith Woodward, F.R.S., to Dr. C. W. Andrews, F.R.S., and to Mr. W. P. Pyecraft, for kind help and for giving me every facility for studying the remains of fossil and recent birds in the National Collection.

The Remains from the Har Dalam Cavern.

The small collection under notice was obtained from the Har Dalam Cavern, and the adherent matrix shows that the specimens were embedded in a layer of red cave-earth. They are rather fragmentary, but a comparatively large number of species are represented and range from a small *Elephas* to the extinct rodent *Leithia*. Most numerous of all are the avian remains, which include those of a hitherto undescribed swan and several other species not previously recorded as occurring in a fossil condition in the island. It will be remembered that Dr. Cooke had already carried out some investigations in this cave, the chief results of which have been described by him and Dr. Smith Woodward †.

MAMMALIA.

Of mammals, there are examples of four species only, two of which call for no special notice here, for *Elephas melitensis* is represented by a scaphoid only, and *Cervus elephus barbarus* by a metatarsus and a phalanx. The remaining two are *Leithia melitensis* and a small species of *Equus*, the specimens of which each show some points of interest.

Leithia.—A small number of rather fragmentary remains of *Leithia* are included in the collection. A few of these agree in size with the larger corresponding specimens in the British Museum Collection, but the others are so very much larger that they almost suggest the existence of a second species, though it behoves one to be careful with regard to size alone

* Scottish Geog. Mag. vol. vi. 1890, p. 453.

† Proc. Roy. Soc. vol. liv. 1893, pp. 274-283.

as a character, more especially when dealing with island forms, if island form this be.

One specimen shows very distinctly the distal joining of the tibia and fibula which, according to Weber*, is an important character distinguishing the Myomorpha from the Sciuromorpha in which these two bones are only joined proximally. Lydekker†, on the other hand, attached little weight to this point, although admitting that a distal union is unknown among living Sciuromorphs. Unfortunately, there is not yet sufficient material available to settle definitely the question of the systematic position of the genus, though the latter author was probably correct in suggesting that *Leithia* constituted a separate family, Leithiidae. This view is strengthened by the fact that two further species of *Leithia*, not yet described, have been discovered by the writer in the cave-deposits of the Balearic Islands. This greatly extends the known range of the genus, which is, no doubt, another representative of the "Tyrrhenian" fauna preserved in the Pleistocene deposits of the islands of the western Mediterranean region.

Through the courtesy of Mr. J. Wilfrid Jackson I have been able to examine an imperfect left mandibular ramus of a small species of fox from the Pleistocene of Malta, belonging to the collection of the Manchester Museum. So far as I am aware, no fox is found in the island at the present day, and still further interest is given to this specimen in that this occurrence of a small carnivore for which *Leithia* would appear to be a suitable prey, suggests that the abundance and tendency towards an increase in size in the rodent can only be explained by the theory that it was at any rate more or less arboreal in habit. That it was not highly specialised for a fossorial mode of life is shown by the shape of the skull and the curvature of the incisors‡.

Equus.—Finds of *Equus*-remains in the Pleistocene cave and fissure deposits of Malta have been very few up to the present, and, so far as I am aware, none has been recorded from the other islands of the Mediterranean, though their occurrence in the Genista Cave, Gibraltar, has been noted by Dr. Hugh Falconer in his list of species from that locality§. Further work in this region will probably yield other finds of a similar kind.

The present collection includes a left upper pm. 2, which is believed to be that of a small horse, for its crown pattern shows the small enamel-fold described as fold 5 ("pli caballin") by Prof. H. F. Osborn, who considers its presence a means of distinguishing molars of *E. caballus* from those of *E. asinus*||. It indicates an animal of about the size of a New Forest pony. The greatest

* 'Die Säugethiere,' Jena, 1904, p. 489.

† Proc. Zool. Soc. 1895, p. 862, footnote.

‡ I am indebted to Mr. M. A. C. Hinton for information kindly given me on this point.

§ Pal. Mem. vol. ii. p. 555, London 1868.

|| Osborn, H. F., "The continuous origin of certain unit characters as observed by a Palaeontologist," Harvey Lectures, Ser. 1911-12, pp. 200-1, fig. 8.

height of the specimen is 63 mm., the antero-posterior width 30 mm., and the thickness 21 mm. Perhaps its chief interest lies in its association with remains of one of the small elephants and those of a large chelonian, thus showing definitely for the first time the contemporaneity of the *Equus*-remains with the rest of the extinct Pleistocene fauna of the island. For Leith Adams wrote that he had no evidence of such a contemporaneity; and, further, an imperfect metacarpus, previously obtained from the Har Dalam Cavern, was found in a superficial layer, and included with remains of man, domestic animals, and rude pottery*. This last example, now in the British Museum Collection, consists of the proximal half only of the metacarpus, the greatest diameter of the articular surface being 38 mm.; it is a somewhat stouter bone than one in the collection of the Manchester Museum. Mr. J. Wilfrid Jackson has made some interesting notes on this last specimen which he very kindly placed at my disposal, and which I feel I cannot do better than quote in full:—

“The Manchester Museum possesses a short and extremely slender adult metacarpal bone of an Equine which was found many years ago in one of the Malta caves associated with remains of *Cervus barbarus*, fox and tortoise. In length the bone measures 160 mm., whilst the width at the middle of the shaft is only 20·7 mm. (index 7·72). The width of the distal end = 29 mm.

“The slenderness of the bone is very remarkable. According to Prof. J. C. Ewart (Proc. Roy. Soc. Edin. xxx. pt. 4, 1910, p. 291), the cannon bones in fossil and recent Asiatic wild asses are long and slender, the length of the metacarpal being at least eight times the width at the middle of the shaft. The index of the Malta bone is 7·72, and therefore suggestive of ass rather than horse, as in the latter the index is never more than 7·5.

“However, assuming it to belong to horse, it would indicate an animal of about 10 hands in height (according to Ewart, *op. cit.* p. 297, footnote), *i.e.* slightly higher than a typical Shetland pony. In a specimen of the latter with a height of 36·5 ins. the metacarpals measured 143 × 25 mm. (*vide* Ewart).

“I believe the British Museum possesses a metacarpal from Auvergne (? Pleistocene) which measures 173 × 24 mm. (index 7·20), which would indicate a slender-limbed animal under 11 hands at the withers.

“Prof. Ewart writes me that he has also a record of a 156 × 25 mm. metacarpal from Seine Inférieure, which means a horse about 9·2 hands.”

AVES.

Owing to its geographical position Malta receives many visitors on migration, which accounts for the large number of recent

* Proc. Royal Soc. vol. liv. 1893, p. 281.

species recorded from the island, which nowadays has only a very small indigenous avifauna. Numerous lists of these have been published; the latest and most complete is one which appeared only last year (1915), and was compiled for the Malta University Museum of Natural History by M. Giuseppe Despott, Curator of that Institution. This brings the record down to December 1914, and contains about 50 species not included in previous lists, while the total comes to over 300.

As might be expected, avian remains from Malta are far less plentiful than those of associated mammals, and an exact determination is often further hampered by the fragmentary condition of many of the specimens, and occasionally by lack of recent material for comparison. It seems most probable that the birds whose remains occur in the cavern deposits were, at least partially, resident in the island. It is not surprising to find species represented that nowadays only occur accidentally or on migration, for the whole character of the extinct Pleistocene fauna of the island shows that the climate, vegetation, and probably the extent of the land surface, were very different from those obtaining at the present day. The fact that anserine birds, including several extinct species, are so largely represented leads one to suppose that they flourished when there were considerable tracts of low-lying and marsh lands, probably before the final submergence of the land (part of which is now known as the Medina Bank) which connected Malta with Sicily and formed a northern extension of the present Tripolitan coast-line.

The present collection includes the distal half of a humerus believed to be that of the Brent Goose (*Branta bernicla*), for it only differs from recent specimens with which it has been compared in being very slightly larger. Other limb-bones appear to be those of the Barnacle Goose (*B. leucopsis*). The former species has already been somewhat doubtfully recorded from Malta, while the writer has obtained remains of the latter from a Pleistocene fissure in Menorca; at the present day these geese occur very sparingly in the Mediterranean, and probably then only on migration.

Remains of several species of Swans have already been obtained from the Maltese cave-deposits, including the very large extinct form, *Cygnus falconeri*, described by Parker*. Of this bird he wrote (p. 123) that it "was rather generalized in character, being somewhat of a goose, possessing as he did longer legs and shorter toes than the typical swans. It would appear, however, that this bird had its wings of the full relative size: the immense ulna shows this." Later, he suggests that "perhaps he was altogether more terrestrial," but I think this was meant as opposed to swimming habits and did not refer to any loss of power of flight. The same author (*loc. cit.*) also described and figured some specimens believed to represent *C. musicus*, at the

* Trans. Zool. Soc. vol. vi. pp. 119-124, pl. xxx.

same time suggesting the possibility of there having been remains of more than these two species of swan in the Zebbug Cave.

A few specimens in the British Museum Collection are said by Lydekker* to "indicate a swan of considerably smaller size than *C. musicus*." None of the remains in the present collection agrees with these last, and only one phalanx is somewhat doubtfully referred to *C. falconeri*. A left femur wanting the inner condyle agrees very closely in size and form with the corresponding bone of *C. musicus* (Brit. Mus. 449 d), and there seems little doubt that it ought to be referred to this species, which has already been recorded from Malta both in a fossil state and as an accidental visitor during severe winters.

The present collection from the Har Dalam Cavern includes a few remains of an anserine bird, believed to be a small swan, which it has been impossible to identify with the corresponding bones of any of the species with which I have been able to compare them, either from Malta or among the recent skeletons in the osteological collection of the British Museum. With the small amount of material available it cannot be said definitely that these specimens all represent a single species, but it is believed that this is so at any rate in the case of a proximal portion of a left humerus, a right coracoid, and a right metacarpus. Besides these, the proximal portions of two ulnæ and perhaps a radius might also be included. It is suggested that this species be known as

CYGNUS EQUITUM, sp. n.

Right metacarpus (text-fig. 1).—It is proposed to take this specimen as the type. It is in a good state of preservation, but has the distal extremity abraded and the central portion of the third metacarpal is absent. It is peculiarly interesting on account of its being relatively very much shorter and stouter than the corresponding bone of any recent species of swan or goose with which I have been able to compare it. This character seems to indicate without much doubt that it belonged to a bird in which the power of flight was already considerably reduced.

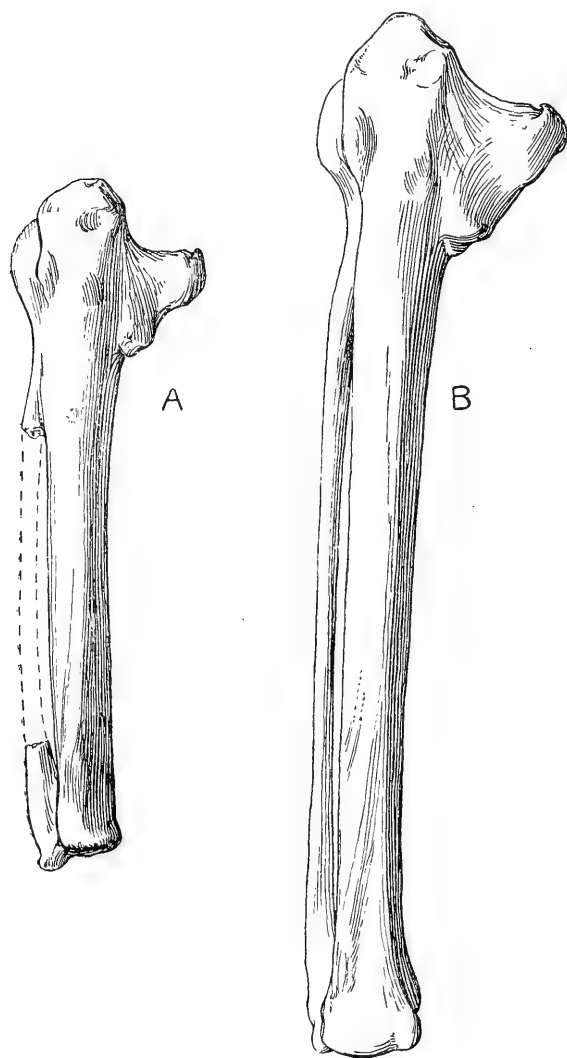
The following measurements, given in millimetres, will show the comparative size of this bone in the Maltese bird, in two recent species of swan, and in *Tachyeres*.

	<i>C. equitum.</i>	<i>C. musicus.</i>	<i>C. olor.</i>	<i>Tachyeres.</i>
Greatest length of metacarpus	90	139	137	61
Greatest diameter of shaft of second metacarpal	8	10·5	10	6
Greatest thickness of proximal articulation	11	13	11	8

* Cat. Foss. Birds in Brit. Mus. 1891, p. 110.

It will be seen from the above that the relative proportions of this bone in *C. equitum* and *Tachyeres* are not very different, which suggests that, as in the latter, *C. equitum* might have

Text-figure 1.



A. Right metacarpus of *Cygnus equitum*.

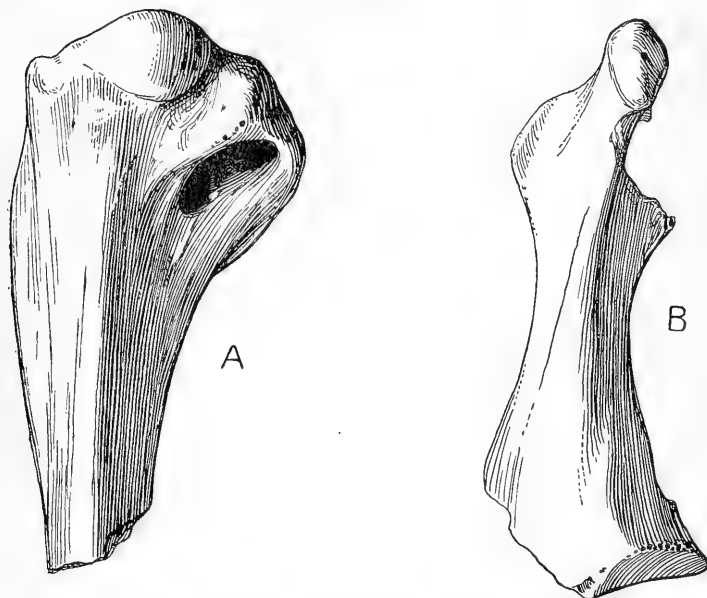
B. Right metacarpus of *C. musicus*.

Both natural size.

lost its power of flight only when the bird attained its full size and weight. In *Tachyeres* the young are said to be able to fly*.

In the large extinct *Cnemiornis calcitrans* it is not only this bone which had been enormously reduced but likewise the other bones of the wing, while the keel of the sternum had almost completely disappeared; whereas in *Tachyeres*, although there is already some reduction in the size of the ulna and radius, the sternum appears to be normal.

Text-figure 2.



A. Proximal portion of left humerus of *Cygnus equitum*.

B. Right coracoid of *C. equitum*.

Both natural size.

Compared with that of *C. olor*, the metacarpus from Malta is relatively a very much shorter and stouter bone; also the third metacarpal is separated from the second for a comparatively much shorter distance, causing the articular ends to be more massive. The first metacarpal is in keeping with the rest of the bone, being large and stout. The proximal articular surface is much flatter than in either *C. olor* or *C. musicus* owing to the pre-axial border being less raised. The comparative proportions of this bone perhaps approach, on the whole, more nearly to those of *C. musicus*, which, judging from the skeletons which

* Owen, "On *Cnemiornis*," Trans. Zool. Soc. vol. ix. 1875, p. 266.

I have examined, appears to be a stouter-limbed bird than *C. olor*.

Humerus (text-fig. 2 A).—The proximal portion of a left humerus believed to belong to the same species as the above metacarpus shows a similar characteristic stoutness of build, and is unlike any specimen with which it has been compared. It is actually very much smaller, but in comparative proportions agrees fairly closely with the corresponding portion of the humerus of *C. musicus*, except that the general outline is squarer and the head and trochanter are stouter, while the subtrochanteric fossa is more definitely defined and much deeper, and the groove separating the head and the trochanter is more deeply excavated.

Coracoid (text-fig. 2 B).—A right coracoid is also believed to be that of *C. equitum*, being of corresponding size and showing the same general characteristics as the two bones described above. This specimen is in a good state of preservation, only wanting the outer portion of its sternal border and the point of the subclavicular process. In comparative proportions it is not unlike the corresponding bone of *C. musicus*, although its ventral aspect is rather different owing to the wider base from which the subclavicular process springs and the greater thickness of the ridge between the head and the main body of the bone. The surfaces of contact with the sternum are wide and shallow.

Ulna.—The collection includes the proximal portions of a right and left ulna, which I have been unable to identify with any recent specimens to which I have had access. They appear to agree in size and robustness with the limb-bones described above and are provisionally ascribed to the same species. Their dorsal aspects show no roughened surfaces for the attachment of the flight-feathers.

Radius.—The distal portion of a radius with about two-thirds of the shaft is more doubtfully assigned to this species, as it is perhaps comparatively rather larger than the two ulnæ.

Two species of Bustards are represented in the collection by a few fragmentary remains. Both these species occasionally occur as stragglers to the island at the present day, but neither has been previously recorded in a fossil state.

The distal portion of a right tibio-tarsus and the proximal portion of a left scapula are referred to *Tetrax campestris*, while the distal extremities of two tarso-metatarsi are ascribed to *Otis tarda*, one being that of a male and the other that of a female bird.

15. The Poison-Organ of the Sting-Ray (*Trygon pastinaca*).
By Tempy.-Major H. MUIR EVANS, M.D. (Lond.),
R.A.M.C.(T).*

[Received March 3, 1916: Read April 18, 1916.]

(Text-figures 1-7.)

PART I. HISTORICAL SUMMARY.

The question of the presence of true poison-organs in fish is one which has exercised the minds of observers for centuries. From Aristotle down to the end of the nineteenth century the presence or absence of a poison-gland in the Sting-Ray has remained an unrevealed secret, although many observers have felt convinced that something besides the laceration by its serrated spines was necessary to cause the pain and inflammation that resulted from injuries produced by it. Even Bottard, to whom I am indebted for most of the early historical literature, denied the presence of a poison apparatus; and the 'Cambridge Natural History' merely states (p. 177) that "among Elasmobranchs the Eagle-Rays (*Aëtobatis*) and Sting-Rays (*Trygon*) have barbed or serrated spines on the tail, which inflict wounds far more severe than those caused by mere mechanical laceration; but, except the mucus secreted by the gland cells of the skin, which may possess venomous properties, no special poison-forming glands in connection with the spines are at present known."

Dr. Antonio Porta contributed a paper on venomous fish to the 'Anatomischer Anzeiger' of March 1, 1905. "It can be seen," he says (p. 235), "by what I have quoted above, that until now it was not known that a poison apparatus existed in the Trygonidae and Myliobatidae. The barb of the Trygon is almost similar to that of the Myliobatides, but it is longer and narrower. The said sting shows the lateral margins deceitfully serrated with the points turned from the back to the front. According to Moreau, in a fish of a medium size, the dart is very nearly one quarter of the length of the back, but there is nothing exact in its proportion. In nine specimens (*T. violacea* and *T. pastinaca*) of medium size that I examined, I found that the length of the dart varied from 8.7 to 12.6 cm. It is renewed every year of the life of the fish, and since sometimes the new one sprouts before the old one falls off, we find individual fish armed with two or, more rarely, three or four stings. If we isolate a sting and examine it, we observe on the ventral aspect two grooves on either side of a ridge which become shallow in width and depth towards the base. In these two grooves the poison-organs are situated, which penetrate to the deepest part of the groove and there continue laterally and above into two small

* Communicated by the SECRETARY.

tubes which converge at the base, providing a passage for the blood capillaries, which supply the connective tissue surrounding the gland."

"On making transverse sections of the sting and putting them under the microscope, we see that the ventral furrows are occupied by a glandular mass of a more or less triangular shape with the corners rounded off. It is composed of a great many cells of various sizes and shapes ($\cdot 2$ – $\cdot 4$ mm. $\times 510$), often joined to one another to form true glandular follicles, which measure $\cdot 7$ – $1\cdot 5$ mm. $\times 510$; the connecting and surrounding tissues are rich in blood-vessels and communicate with the sheath of the sting. Towards the apex the gland gets smaller, the cells become less numerous and smaller and are surrounded by much connective tissue, with which they gradually merge."

"This gland is similar to that which is observed in the genus *Scorpæna* and in the greater number of other poisonous fish. It should be considered as a cutaneous gland. The dart is merely an arm of defence. It is united to the tail by strong ligaments and muscles, which only, however, permit a small lateral movement. The emission of the poison takes place in a very simple manner. The sting introducing itself into the wound, the sheath is drawn back towards the base and presses on the gland which thus emits a poisonous liquid, which flowing towards the narrow apical groove thus inoculates the wound."

PART II. OBSERVATIONS ON SERIAL SECTIONS.

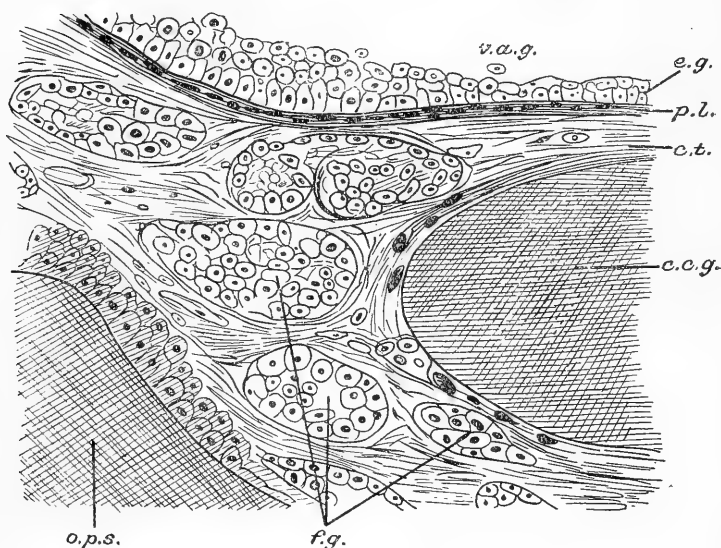
I am in agreement with Dr. Porta as to the position and general triangular outline of the gland. I have not personally examined the poison-organ of *Scorpæna*, but the elongated compressed cells pictured by Bottard in the grooves of the spine of *Scorpæna* are of the same type as the gland-cells of both *Trachinus draco* and *vipera*, and according to that authority the poison-gland of *Scorpæna* is a less developed type of the gland found in the Weevers. Having myself made many sections of the glands of both the Great and Lesser Weevers, I can state with assurance that the glandular structure found in *Trygon* is of a totally different type: in fact, there are many points in its structure of a unique character, and the arrangement of the cells requires careful examination. The gland consists, for the most part, of a fine mesh, within the interstices of which are groups of small cells with a vacuolated protoplasm. These cells are grouped together in regular follicles.

These follicles in other parts are entirely filled with secretion, so that you have a cystic appearance, a distended cavity, lined by a layer of flattened cells. The external margin of this glandular mass shows a well-marked layer of pigment-cells, and external to this are several layers of rounded epithelial cells, which, however, are frequently detached in the sections, as shown in text-fig. 2.

If we could understand the origin and relations to other parts

of the tissues which occupy the lateral grooves, which for convenience and brevity I propose in future to speak of as the glandular triangle (Porta speaks of it having a triangular shape in section with the angles rounded off), we must study sections at the root of the spine or dart, before it separates from the whip-like tail. With the naked eye one can see a special dark pigmented patch on the tail where it opposes the spine, on the surface of which appears some soft whitish epidermis. Moreover, if we view the spine at this point in profile, we notice that

Text-figure 1.

*Trygon pastinaca.*

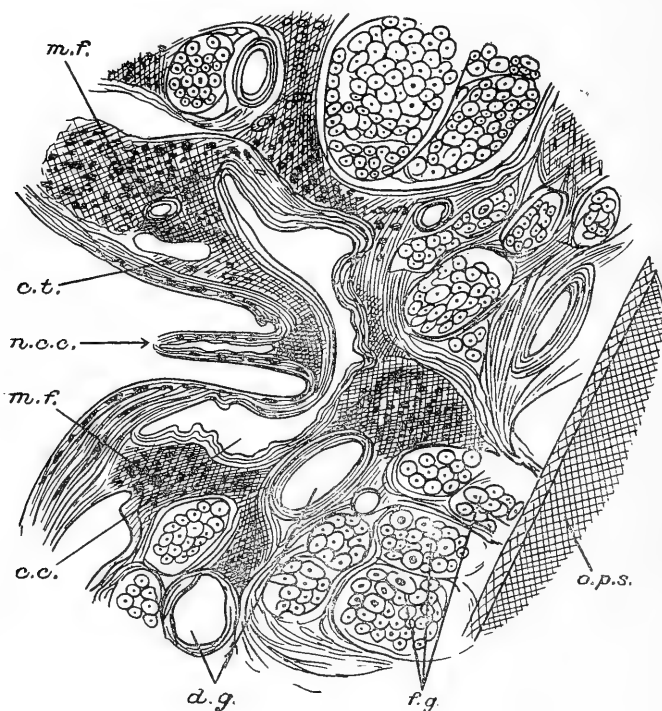
Part of gland in groove.

c.c.g. Central canal of groove. *c.t.* connective tissue. *e.g.* epithelium of groove.
f.g. follicles of gland. *o.p.s.* osseous part of spine. *p.l.* pigment-layer.
v.a.g. ventral aspect of groove.

the dorsum of the spine becomes free of the epidermis which has been covering it sooner than the ventral aspect, so that the dorsum of the spine in this respect is somewhat similar to the nail on a man's finger. The epidermis ends rather abruptly on the dorsum, while, on the other hand, the dentate margin and the lateral grooves between it and the ventral ridge separate gradually from the tail, the last part to become free being the ventral ridge. On either side there is a gradual invagination of ectoderm between the tail and the glandular triangle, this

invagination becoming deeper as one traces it posteriorly. Microscopically, one can observe that this invagination is carried out by a specialised portion of epithelium. Where the spine begins to separate, the flattened epidermal layer and mucous cells covering the tail are replaced by a layer of columnar cells

Text-figure 2.



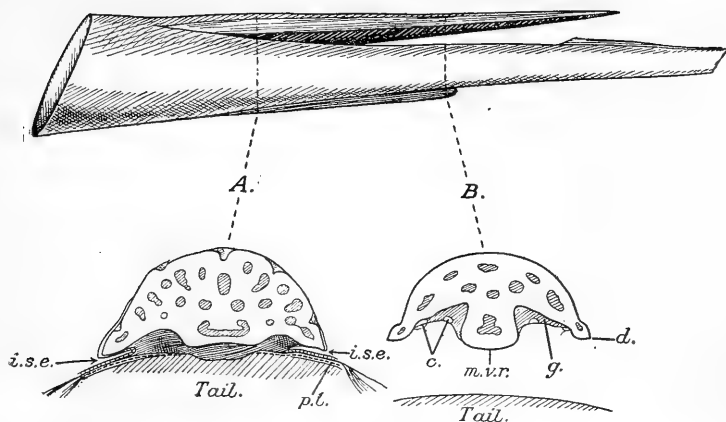
Trygon pastinaca.

Portion of gland of groove, showing follicles full of secreting cells, and central canal empty.

c.c. Central canal or duct (empty). *c.t.* connective tissue. *d.g.* ducts of gland. *f.g.* follicles of gland. *m.f.* muscle-fibres. *n.c.c.* nipple of central canal. *o.p.s.* osseous portion of spine.

with superimposed layers of rounded cells, resting on a basement-membrane in which is a layer of large deeply pigmented cells. This peculiar layer of epithelial tissue gradually grows inwards, *i. e.*, towards the middle line on either side, and inserts itself between the tissues occupying the grooves and the tail.

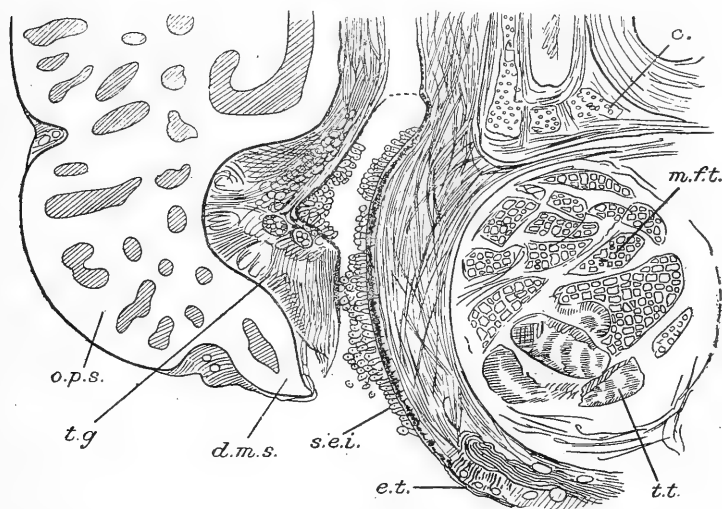
Text-figure 3.

*Trygon pastinaca.*

Lateral view of spine, with diagrammatic sections at A, B.

c. Canals. *d.* tooth. *g.* glandular tissue. *i.s.e.* invagination of specialised epithelium. *m.v.r.* median ventral ridge. *p.l.* pigment-layer.

Text-figure 4.

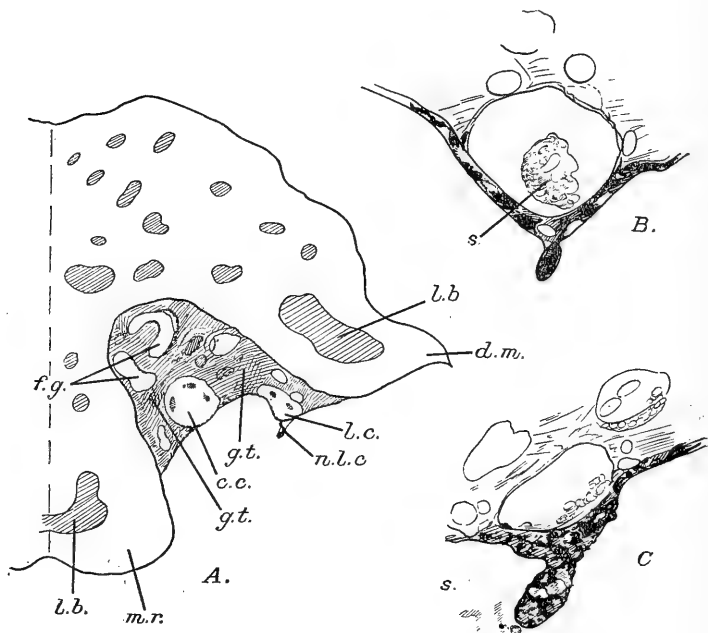
*Trygon pastinaca.*

Half-section of spine separating from tail, showing invagination of specialised epithelium and pigment-layer.

c. Cartilage. *d.m.s.* dentate margin of spine. *e.t.* ordinary epithelium of tail. *m.f.t.* muscle-fibres of tail. *o.p.s.* osseous portion of spine. *s.e.i.* special epithelium of invagination. *t.g.* tissue of groove. *t.t.* tendon of tail.

The tissue of the triangle at this stage consists of the fibrous tissue which precedes the formation of bone; the pigmented layer and the round cells in this way extend over the tissue of the groove, and the actual separation of the spine from the tail is accomplished by a division of the round-celled epithelium, so that when the separation is complete there is a pigment-layer covering the glandular triangle covered with several layers of epithelium, and a similar pigment-layer with epithelial covering facing it on the dorsal surface of the tail.

Text-figure 5.

*Trygon pastinaca.*

- A. Transverse section of spine near base.
 B. Lateral canal and nipple. Canal full.
 C. " " " Canal emptying.

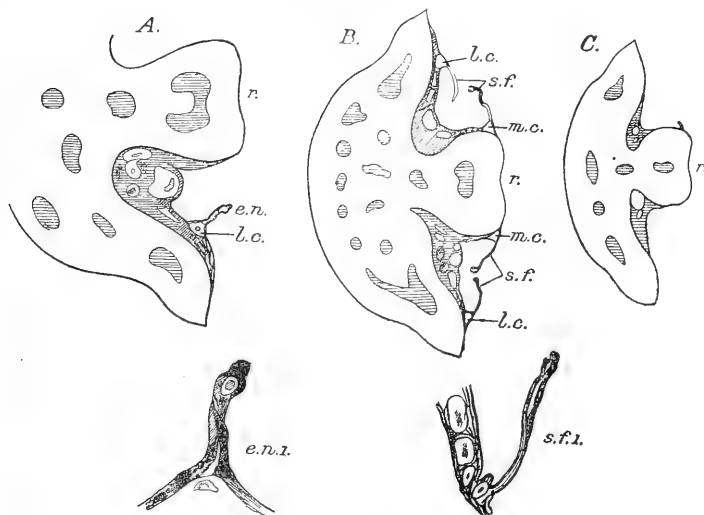
c.c. Central canal. *d.m.* dentate margin. *f.g.* follicles of gland. *g.t.* glandular tissue.
l.b. lacunae of bone. *l.c.* lateral canal. *m.r.* median ridge. *n.l.c.* nipple of lateral canal. *s.* secretion.

The pigment-layer may also be observed to dip into the triangular area, and carries with it these rounded cells.

If we now examine more carefully the secreting tissue of the glandular triangle, we notice throughout the length of the groove, but more markedly near its base, two definite rounded

cavities, occupied by a mass of homogeneous yellow material staining yellow by Van Giesen's method. These cavities tend throughout the whole series of sections to arrange themselves into two ducts or canals, one lying near the centre of the gland or towards the ridge, and the other lying towards the lateral margin in the direction of the teeth. The follicles seem to empty themselves either into one canal or the other. As each duct or canal becomes filled with secretion it bulges the pigment-layer so as to make it protrude externally. On the peripheral margin of the lateral canal this bulge is surmounted by a curious nipple-shaped projection which appears throughout the whole series of sections, at times distended, at times empty and flattened. Some of the sections show the nipple discharging a fluid from its

Text-figure 6.

*Trygon pastinaca.*

A-C. Series of sections progressively diminishing towards tip.

e.n. Elongated nipple. *e.n.l.* the same enlarged (note bulbous tip containing secretion). *l.c.* lateral canal. *m.c.* canal of median ridge (*r.*). *s.f.* secreting filaments. *s.f.l.* the same enlarged.

tip, and one feels convinced that these sections actually show the secretion from the lateral canal being discharged externally. Towards the tip of the spine, where the groove is smaller, the nipple is prolonged into a filamentous tube.

By counting the sections in series and observing the presence or absence of a nipple-like projection from the lateral canal, one is able to estimate approximately the size of these projections.

A nipple will extend for .3-.4 mm., and there is then a gap of about .2 mm. until the next nipple appears on the lateral canal. In this way the dentate margin is moistened with secretion, and as the teeth lacerate the tissue of the victim the poison becomes inoculated in the wound. Towards the tip of the spine there is little glandular tissue: the central canal divides into two or more channels, and the secretion is discharged by means of a canal, of which there are two on either side, a lateral canal near the base of the teeth, and a canal resting on the margin of the median ridge where it looks towards the lateral groove.

Text-figure 7.

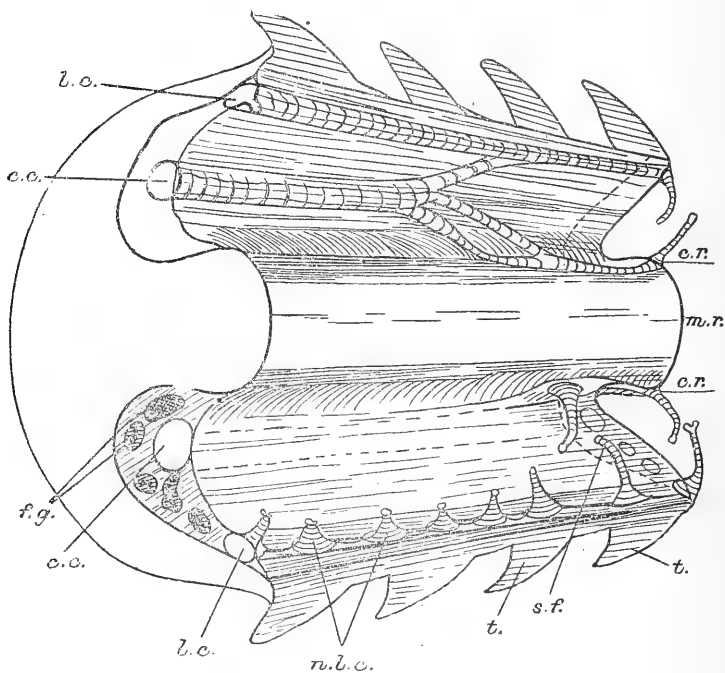
*Trygon pastinaca.*

Diagram of portion of spine to show scheme of canals and relations of nipples and filaments.

c.c. Central canal. c.r. canal of ridge. f.g. follicles of gland. l.c. lateral canal. m.r. median ridge. n.l.c. nipples of lateral canal. s.f. secretory filaments. t. tooth pointing forwards.

It is here that these lateral canals give off the hollow filamentous tubes, which project towards each other and are of such length that the two make a bridge across the lateral groove. They

terminate by an orifice which is curiously pigmented, and some sections show the secretion issuing from the tip.

The number of these secreting filaments varies, and apparently they are provided in order to carry the poison to the tip of the dart, where the glandular tissue no longer is present. The width of a filament is from 2 to 3 mm.

It should be mentioned that in one spine of the three of which I have sections, there is a well-marked nipple projecting from the central canal near the base (see text-fig. 2), and the canal can be seen surrounded by a layer of muscular fibres.

A diagram of this arrangement of glandular tissue, central and lateral canals, nipples and secreting filaments, is given in text-fig. 7; it is purely diagrammatic, and does not give with any pretence of accuracy the actual relative size of the nipples compared with the teeth of the dentate margin.

In concluding this account of the microscopic anatomy of the spine, I must mention with gratitude the help I have received from Dr. Stuart McDonald, of the University of Durham, whose laboratory assistant, Mr. Percy Landreth, took the microphotographs from which several of the illustrations have been prepared, and who gave me much technical help.

I must also mention the kindness of Mr. C. Tate Regan, of the British Museum (Natural History), in looking at my sections, in giving me references to the literature on the subject, and making suggestions as to the form this paper should take.

I must also thank those members of the Board of Agriculture and Fisheries, including Mr. Borley, for the help they have given me in obtaining specimens.

In conclusion, I would add that my investigations began in 1911, and were undertaken in ignorance of the work of Dr. Porta, who, so far as I can ascertain, was the first to describe the gland of the groove in the spine of *Trygon*.

Summary of the evidence that the gland is really a poison-organ:—

- i. That the nature of the wounds produced are not such as would happen after a simple laceration;
- ii. that the symptoms of acute pain and inflammation are similar to the symptoms produced by the stings of the other venomous fish, particularly the weever;
- iii. that the staining reactions of the secretion are similar to the staining reactions of the poison of *Trachinus draco*;
- iv. the observations of Dr. Lo Bianco quoted by Dr. Porta.

The observations of Dr. Lo Bianco are very interesting. He himself saw a young man become extremely pale and fall down almost senseless for a few minutes, from having received only a very small puncture while he was in the act of passing a *Trygon* weighing 3 kg. from one person to another. Besides which he also relates the following most interesting fact. In the month of

September there were in the great tank of the Aquarium of the Zoological Station of Naples four *Trygon violacea* and three *Thalassochelys caretta*. One of the Trygons died, and on examining it he found that the sting was broken and entirely gone. After a few days one of the *Thalassochelys* would not eat any more, unlike the others who ate with great appetite, and remained in a corner of the tank: it lived thus for four days and died on the fifth. On examining it he found the sting of the *Trygon* buried quite 6 cm. under its right fin, piercing only the skin and muscles; in the part where the sting was buried the tissue was of a violet colour. The wound was about 3 to 4 cm. in length and breadth, and contained a putrid liquid with a most offensive smell.

The results of this investigation show:—

- i. The origin of the gland from a special layer of epithelium starting at the root of the spine.
- ii. That the secreting tissue consists of regular follicles with ducts and central and lateral canals.
- iii. That the secretion is discharged by means of nipples or filaments projecting from the canals.
- iv. That there is a layer of muscular tissue surrounding the central canal.

Works consulted.

1. BOTTARD'S "Les Poissons venimeux," 1889.
2. KOBERT'S "Giftfische und Fischgifte," 1902.
3. PORTA'S paper in the "Anatomischer Anzeiger," xxvi. 1905.
4. CALMETTE'S "Les Venins," 1907.
5. Cambridge Natural History, Fishes, 1904.

There are full bibliographies in Bottard's work and in Porta's paper.

EXHIBITIONS AND NOTICES.

March 21st, 1916.

Dr. S. F. HARMER, M.A., F.R.S., Vice-President,
in the Chair.

The SECRETARY read the following report on the Additions to the Society's Menagerie during the month of February, 1916 :—

The number of registered additions to the Society's Menagerie during the month of February was 36. Of these 30 were acquired by presentation, 5 were received on deposit, and 1 by purchase.

The number of departures during the same period, by death and removals, was 145.

Amongst the additions special attention may be directed to :—

1 Preuss's Cercopitheque (*Cercopithecus preussi*), from the Cameroons, presented by Major Sir George Noble, Bart., F.Z.S., on February 21st.

1 Korin Gazelle (*Gazella rufifrons*), from the Soudan, presented by Capt. William Dyer, on February 24th.

Mr. E. T. NEWTON, F.R.S., F.Z.S., exhibited the pelt and bones of a Black Hare, for which he was under obligation to Mr. G. F. Brooke of Leadenhall Market, who had received it with a large consignment of Brown Hares from Siberia; but, unfortunately, the locality was not known. This hare is of small size and with short rabbit-like ears. The head and back are black excepting only a small white spot on the forehead; and towards the sides there are numerous long hairs with white tips. Lower down upon the sides the fur becomes tawny and passes into white underneath. All the feet, but especially the hinder ones, have light brown hair up the upper parts.

The skull and limb bones show characters agreeing with those of the hare; but in size the animal was intermediate between our common hare and the rabbit.

Mr. D. M. S. WATSON, F.Z.S., gave an account of some observations he had made on the habits and life-history of *Platypus* and *Echidna*.

The Alisphenoid Canal in Civets and Hyænas.

Mr. R. I. Pockock, F.R.S., F.L.S., F.Z.S., Curator of Mammals, gave an exhibition, illustrated by lantern-slides, to show some points connected with the alisphenoid canal in the Viverridæ* and Hyænidæ, and remarked:—

“As is well known, the alisphenoid canal is always absent in the Felidæ (text-fig. 1, A). In the Viverridæ, on the contrary, it is nearly always present, although it is never found in the Mascarene genera *Galidia*, *Galidictis*, and *Salanoia* (text-fig. 1, B), forming the subfamily Galidictinæ, and may be present or absent in *Cynogale* (Cynogalinæ) and *Eupleres* (Euplerinæ), two aberrant genera of Viverridæ. By Mivart, Flower, and authors inspired by them, it is also stated to be variable in its occurrence in *Viverricula*, a genus closely related to *Viverra* and *Genetta*, in which it is always present.

“Examination of the skulls of *Cynogale* and *Eupleres* shows conclusively that the absence of this canal, when it is absent, is due to suppression, complete or partial, of its external bony wall. Nevertheless, when this wall is unossified in these forms, the channel marking the course of the external carotid artery is very apparent. This bony wall is also so short in some Mongooses, e. g. *Crossarchus*, that a comparatively slight defect in ossification would convert the canal into an open channel, such as is seen sometimes in *Cynogale* and *Eupleres*. In *Crossarchus* (text-fig. 1, C, D), *Cynogale*, and *Eupleres*, moreover, the *foramen rotundum* opens alongside the anterior orifice of the alisphenoid canal into the posterior part of the temporal fossa close to the sphenoidal fissure (*foramen lacerum anticum*). In the Galidictinæ the *foramen rotundum* occupies precisely the same position with regard to the sphenoidal fissure. This part of the skull in *Galidictis*, for example, bears a close resemblance to that of *Crossarchus*, except that there is no trace whatever of the alisphenoid canal. Nevertheless, the general likeness alluded to suggests that the absence of the canal in *Galidictis* may be due to the complete suppression of its outer wall (text-fig. 1, B).

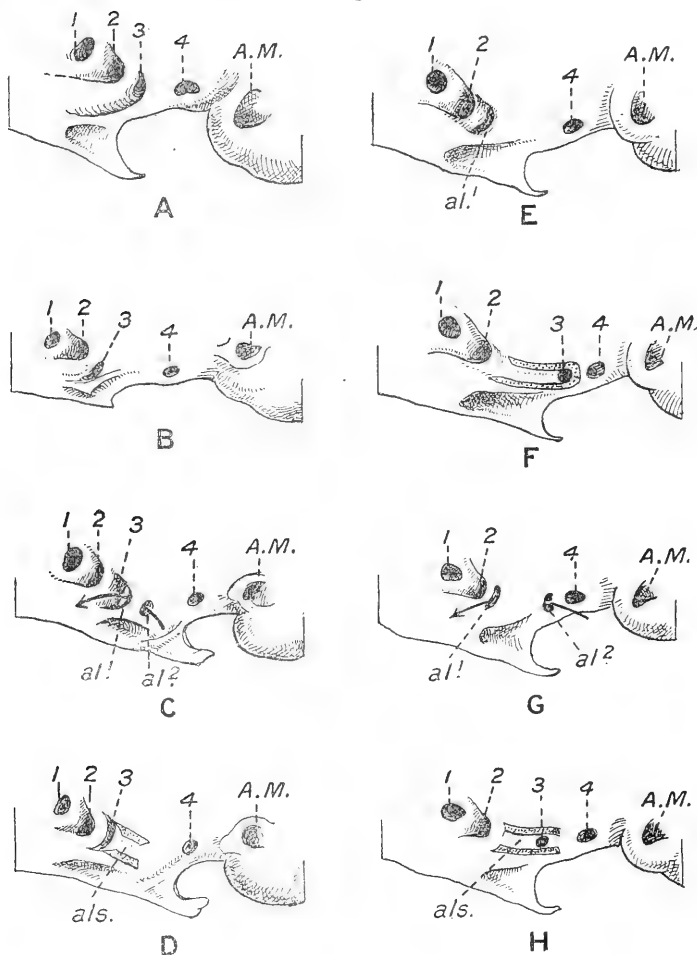
“This interpretation seems to be the one that is currently accepted; and since no alternative has, so far as I am aware, been suggested, it may be assumed that the same explanation has been tacitly extended to those specimens of *Viverricula* in which the canal has been described as absent (text-fig. 1, E). The statement, however, that the canal is absent in that genus is not true. It is in reality present, its apparent absence being due to the closure of its posterior orifice and not to the imperfection of its outer wall.

“Justification for this view rests upon the following facts:—

“The orifice, lying alongside the sphenoidal fissure in *Viverricula*, which Flower would doubtless have called the *foramen rotundum*, is in reality the anterior end of the alisphenoid canal, which, when complete, opens posteriorly by a small aperture just

* The term Viverridæ is here used, without prejudice, in the sense in which Flower and Mivart and their successors employed it.

Text-figure 1.



- A. Left cranial foramina of *Felis* with zygoma cut away. 1. optic foramen; 2. sphenoidal fissure (*foramen lacerum anticum*); 3. foramen rotundum; 4. foramen ovale; A.M. auditory meatus.
- B. The same of *Galidictis*.
- C. The same of *Crossarchus*. *al.*¹ anterior, and *al.*² posterior orifice of alisphenoid canal with bristle passed through it.
- D. The same with outer wall of alisphenoid canal (*als.*) cut away.
- E. The same of *Viverricula* with posterior orifice of canal closed.
- F. The same with outer wall of canal cut away to show foramen rotundum (3) opening into posterior end of canal.
- G. The same of *Genetta*, showing the complete alisphenoid canal concealing the foramen rotundum.
- H. The same with the outer wall of the canal cut away, exposing the foramen rotundum opening into it.

in front of the *foramen ovale*. When this aperture is absent, the presence of the canal may be demonstrated by cutting away its outer wall backwards from its anterior orifice. The true *foramen rotundum* will then be revealed perforating the cranial floor at the posterior end of the canal a little in advance of the *foramen ovale* on the admedian side (text-fig. 1, F). Hence in *Viverricula* the *foramen rotundum* opens into the alisphenoid canal, or, if the term 'canal' be inadmissible for a tube closed at one end, into the alisphenoid tube representing the canal.

"It may be added that this region of the skull in *Viverricula* is alike in all specimens, apart from the presence or absence of the posterior orifice of the canal, which may be represented by a hole only large enough to insert a needle. Whereas if the alleged absence of the canal were due to the suppression of its outer wall, the canal would be represented by a groove, as in *Cynogale* and *Eupleres*, which is not the case, and the *foramen rotundum* in *Viverricula* would have to be described as a long tube, to which no parallel can be found in the *Æluroidæ*.

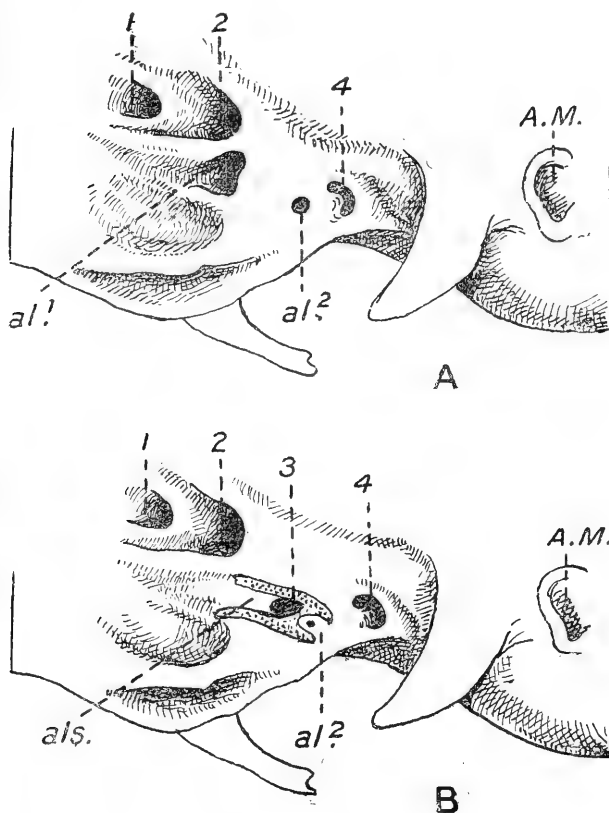
"That the interpretation above given is correct may be further shown by comparing *Viverricula* with *Genetta* (text-fig. 1, G, H), *Civettictis*, and other genera where the *foramen rotundum*, piercing the skull, may be seen within the alisphenoid canal by looking through its posterior orifice, the aperture in the skull close to the sphenoidal fissure being the anterior orifice of the canal and not the *foramen rotundum* of the *Felidæ*.

"The alisphenoid canal is also stated in current literature to be absent in the *Hyænidæ*; and this opinion seems to date from Turner's rejection in 1848 (P. Z. S. 1848, p. 81) of Cuvier's statement in 1837 that it is present in these animals. Cuvier's words are:—'Dans l'hyène . . . le trou optique, le sphéno-orbitaire, le rond, le vidien [alisphenoid canal] et l'ovale différent peu du chien. J'ai un individu où il y a un canal vidien d'un côté et pas de l'autre' (Anat. Comp. ed. 2, ii. p. 471). This assertion, suggesting that the canal is generally present and exceptionally absent, is not altogether correct; nevertheless, Turner, Flower, and Mivart were wrong in citing the absence of the canal as characteristic of the family *Hyænidæ*. It is usually absent but sometimes present, at all events in *Crocota* (text-fig. 2). It is much shorter than in *Viverricula*. Nevertheless, its apparent absence is due to the same process as in that genus, namely the obliteration of its posterior orifice. There is sometimes no trace of this orifice; but quite commonly it is represented by a small aperture a little in front of the *foramen ovale*. This aperture may lead into a very short blindly ending tube, whence a small hole, also to be seen at the posterior end of the canal in *Canis*, penetrates the sphenoid bone (text-fig. 2, B). In other and rarer cases where this aperture is larger, a bristle passed into it emerges at a tolerably large foramen lying beneath the hinder end of the sphenoidal fissure in the temporal fossa. This foramen is the anterior end of the canal and not the *foramen rotundum* which perforates the base of the skull within the canal behind

that orifice as in *Viverricula*, as may be shown by cutting away the wall of the canal.

"The arrangement above described is, so far as my observations go, much more obvious in the Spotted Hyæna (*Crocota*) than in the Striped Hyæna (*Hyæna*). In both genera there may be no trace of the posterior orifice, but in *Hyæna* this orifice, when present, is apparently always quite small and never completes the canal. The *foramen rotundum*, moreover, is set more forwards, so that to all intents and purposes it opens direct into the temporal fossa as in the *Felidæ*."

Text-figure 2.



- A. Left cranial foramina of *Crocota* (Spotted Hyæna) with zygoma cut away. 1. optic foramen; 2. sphenoidal fissure (*foramen lacerum anticum*); 4. foramen ovale; A.M. auditory meatus; *al.¹* anterior orifice of alisphenoid canal; *al.²* partially obliterated posterior orifice of the canal.
- B. The same with the outer wall of the alisphenoid canal (*als.*) cut away, exposing the foramen rotundum (3) opening into it and showing the posterior orifice of the canal *al.²* with its minute foramen, shut off by bone from the main portion of the canal. When this bone is absent, the canal is complete from end to end.

April 4th, 1916.

Dr. A. SMITH WOODWARD, F.R.S., Vice-President,
in the Chair.

MR. J. T. CUNNINGHAM, M.A., F.Z.S., exhibited a number of skins of fowls produced in the course of six generations descended from a cross between a male *Gallus bankiva* and a female Silky fowl. The cross was made at the Society's Gardens in 1910, and Mr. Cunningham's specimens were bred from a pair of the F1's given to him in 1911.

The chief points illustrated were:—

(1) The production of a recessive pile, instead of pure white recessives; in the pile the female had reddish brown on the breast and abdomen, the male had no colour on the abdomen, but yellow on the back and loins. In the first mature plumage both sexes had reddish brown on the breast.

(2) The production of two types in the coloured dominants, as well as individual variations. One type was dark, the other light: in the former there was an excess of the black colour, especially about the head, in the latter the head was yellow. The difference was more conspicuous in the females than in the males.

Individual differences were shown in comparing a hen with vinous-red colour over a considerable part of the body, especially the breast and wings, and another in which there was no vinous colour, but a neutral drab. These facts seem to indicate that segregation occurs between colour and white in Mendelian fashion, but that the segregation is not complete, that the colour is not a permanent unit, but undergoes subdivision.

MR. D. SETH-SMITH, F.Z.S., Curator of Birds, exhibited lantern-slide photographs of "intensive" poultry-houses, and remarked that the Council had decided to hold an exhibition of laying hens, kept on the intensive system, with a view to educating the public to the possibility and importance of keeping poultry for egg-production, even though their accommodation was limited to a suburban garden or even a back-yard. The system was explained, and stress laid upon the importance of correct feeding and sufficient exercise, the latter being provided by the birds being compelled to scratch for their grain, which must be buried under deep litter.

The Exhibitor stated that the houses were of three sizes, to accommodate from six to thirty birds, and had been lent to the Society by Mr. Randolph Meech, who was the pioneer of the system in this country. The exhibition would be open to the public on April 8th, and some two hundred birds would be on view.

Prof. J. P. HILL, D.Sc., F.R.S., F.Z.S., exhibited living specimens of the Cæcilian, *Siphonops annulatus*, collected by the Percy Sladen Expedition at Theresopolis, Serra dos Orgaos, Brazil, in October 1913. He also exhibited a series of photographs of embryos of the same, obtained from eggs laid at University College.

Mr. G. A. BOULENGER, F.R.S., F.Z.S., read a paper "On the Lizards allied to *Lacerta muralis*, with an Account of *Lacerta agilis* and *L. parva*."

This paper will be published in the 'Transactions.'

April 18th, 1916.

Dr. S. F. HARMER, M.A., F.R.S., Vice-President,
in the Chair.

The SECRETARY read the following Report on the Additions to the Society's Menagerie during the month of March, 1916.

The number of registered additions to the Society's Menagerie during the month of March was 176. Of these 116 were acquired by presentation, 5 were received on deposit, 50 by purchase, and 5 were born in the Gardens.

The number of departures during the same period, by death and removals, was 158.

Amongst the additions special attention may be directed to:—

2 Drills (*Papio leucophaeus*), from W. Africa, purchased March 16th.

1 Bay Duiker (*Cephalophus dorsalis*), from Togoland, presented by O. H. Bohner, on March 23rd.

2 Thar (*Hemitragus jemlaicus*), from Chamba, presented by the Government of the Punjab, on March 20th.

2 Axis Deer (*Axis axis*), from India, and 3 Bennett's Wallabies (*Macropus bennetti*), from Tasmania, presented by Sir Edmund G. Loder, Bart., V.P.Z.S., on March 21st.

The SECRETARY read a letter he had received from Lt.-Col. R. T. Leiper, D.Sc., F.Z.S., R.A.M.C., on the subject of his recent investigations in reference to Bilharziosis, the life-history of the parasite and prophylactic measures.

Mr. C. TATE REGAN, M.A., F.Z.S., gave an exhibition of lantern-slides illustrating how certain fishes protect their eggs by carrying them about, either in the mouth (*Arius*, some Cichlidae), on the occiput (*Kurtus*), on the abdomen (*Aspredo*), or in a special brood-pouch (Syngnathidae).

May 9th, 1916.

Dr. S. F. HARMER, M.A., F.R.S., Vice-President,
in the Chair.

The SECRETARY read the following report on the Additions to the Society's Menagerie during the month of April, 1916 :—

The number of registered additions to the Society's Menagerie during the month of April was 90. Of these 36 were acquired by presentation, 23 were received on deposit, 30 by purchase, and 1 was born in the Gardens.

The number of departures during the same period, by death and removals, was 117.

Amongst the additions special attention may be directed to :—

2 Capybaras (*Hydrochærus hydrochærus*), from South America, presented by Sir Edmund G. Loder, Bart., V.P.Z.S., on April 18th.

1 Long-haired Armadillo (*Euphractus vellerosus pannosus*), from Cordova, presented by Wilfred A. Smithers, C.M.Z.S., on April 10th.

2 Australian Barn-Owls (*Strix delicatula*), from Kalgoorlie, Western Australia, presented by Dr. J. Vere Arkle, on April 3rd.

3 South-American Cæcilians (*Siphonops annulatus*), from Brazil, presented by Prof. J. P. Hill, F.R.S., F.Z.S., on April 4th.

Mr. R. H. BURNE, M.A., F.Z.S., exhibited preparations from the Royal College of Surgeons Museum of various Teleostean Fishes*, showing connections of different kinds between the swim-bladder and the ear. The fishes belonged to several distinct families. In some (Berycidæ, Gadidæ, Hyodontidæ, Notopteridæ) the connection was shown to be by direct contact between a process of the swim-bladder and a fenestra in the periotic capsule, or even (Clupeidæ) between the swim-bladder and part of the internal ear; while in others (Ostariophysi) it is indirect and the swim-bladder is connected with the perilymph spaces that surround the ear by a chain of ossicles (Weberian ossicles).

It was suggested that the above connections are probably an aid in the perception of sound, and, in furtherance of this view, specimens were shown of the "elastic spring" mechanism in several Siluroids, by which the walls and contained gases of the swim-bladder can be made to give rise to sonorous vibrations.

* Presented to the College by Col. C. E. Shepherd.

CORRECTION.

On p. 109 of Prof. Poulton's paper on Moths from Somaliland "Genus *Pachycoa*" should read: "Genus *Pachycoa*, nov."

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

April 4th, 1916.

Dr. A. SMITH WOODWARD, F.R.S., Vice-President,
in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

Mr. J. T. CUNNINGHAM, M.A., F.Z.S., exhibited a number of skins of fowls produced in the course of six generations descended from a cross between a male *Gallus bankiva* and a female Silky fowl. The cross was made at the Society's Gardens in 1910, and Mr. Cunningham's specimens were bred from a pair of the F1's given to him in 1911.

The chief points illustrated were:—

(1) The production of a recessive pile, instead of pure white recessives; in the pile the female had reddish brown on the breast and abdomen, the male had no colour on the abdomen, but yellow on the back and loins. In the first mature plumage both sexes had reddish brown on the breast.

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vinous-red colour over a considerable part of the body, especially the breast and wings, and another in which there was no vinous colour, but a neutral drab. These facts seem to indicate that segregation occurs between colour and white in Mendelian fashion, but that the segregation is not complete, that the colour is not a permanent unit, but undergoes subdivision.

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Mr. G. A. BOULENGER, F.R.S., F.Z.S., read a paper "On the Lizards allied to *Lacerta muralis*, with an Account of *Lacerta agilis* and *L. parva*."

This paper is the third and last instalment of a revision of the Wall-Lizards, of which the first two parts were published in the 'Transactions' in 1905 and 1913.

The author has endeavoured to depart from the empirical method usually followed in the arrangement of species, by tracing back the various forms of this difficult group to a hypothetical ancestor of which *Lacerta agilis* appears to be the nearest living representative. The characters of lepidosis and coloration on which his views are based are discussed, and detailed descriptions are given of *L. agilis* and its ally *L. parva*, the latter being regarded as the connecting-link between the first and fourth of the six sections into which it is proposed to divide the genus *Lacerta*. All the species of the fourth section, of which the type, *L. muralis*, has been dealt with in the previous contri-

butions, are described with comments on their mutual relationships. The author's views on the evolution of markings agree with Eimer's well-known theory, but the original pattern is carried back to a type more primitive than any postulated by Eimer, in which a light vertebral streak is present. The lines of evolution are held to be the reverse of those advocated more recently by Prof. von M  hely.

This paper will be published in the 'Transactions.'

Mr. BOULENGER also read a short paper containing an account of some specimens of the Perciform Fish, *Tilapia nilotica*, with increased number of anal spines.

Mr. ROBERT GURNEY, M.A., F.Z.S., communicated a paper on a collection of Freshwater Entomostraca made by Mr. G. W. Smith in Ceylon in 1907. The collection contained examples of 35 species, and one species of Copepoda and two of Ostracoda were described as new, one of the latter belonging to the typically African genus *Oncocypris*.

A paper was received from Major R. MEINERTZHAGEN, F.Z.S., on the Sitatungas (*Limnotragus*) of the Sesse Islands. The author found that the Bugalla Island antelopes of this genus seem to be of the same race as the mainland form, *Limnotragus spekei*, but that the Nkose Island form, which he proposed as a new subspecies, differed in the shortness of its hoofs and other characters.

The next Meeting of the Society for Scientific Business will be held on Tuesday, April 18th, 1916, at half-past FIVE o'clock P.M., when the following communications will be made:—

EXHIBITIONS AND NOTICES.

R. I. POCKOCK, F.R.S., F.L.S., F.Z.S.

On the External Characters of the Mongooses (Mungotid  ).

Major H. MUIR EVANS, M.D., R.A.M.C.

The Poison-Organ of the Sting-Ray (*Trygon pastinaca*).

The following Paper has been received :—

Dr. J. C. MOTTRAM.

An Experimental Determination of the Factors which cause Patterns to appear conspicuous in Nature.

The Publication Committee desire to call the attention of those who propose to offer Papers to the Society, to the great increase in the cost of paper and printing. This will render it necessary for the present that papers should be condensed, and be limited so far as possible to the description of new results.

Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,

Secretary.

ZOOLOGICAL SOCIETY OF LONDON,
REGENT'S PARK, LONDON, N.W.

April 11th, 1916.

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

April 18th, 1916.

Dr. S. F. HARMER, M.A., F.R.S., Vice-President,
in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

The SECRETARY read a Report on the Additions to the Society's Menagerie during the month of March 1916.

The SECRETARY read a letter he had received from Lt.-Col. R. T. Leiper, D.Sc., F.Z.S., R.A.M.C., on the subject of his recent investigations in reference to Bilharziosis, the life-history of the parasite and prophylactic measures.

Mr. C. TATE REGAN, M.A., F.Z.S., gave an exhibition of lantern-slides illustrating how certain fishes protect their eggs by carrying them about, either in the mouth (*Arius*, some Cichlidæ), on the occiput (*Kurtus*), on the abdomen (*Aspredo*), or in a special brood-pouch (Syngnathidæ).

Major H. M. EVANS, M.D., R.A.M.C., read a paper "On the Poison Organ of the Sting-Ray (*Trygon pastinaca*)."

It has been observed for centuries that the wounds produced by the serrated spine growing from the base of the whip-like tail of the Sting-Ray produced very severe injuries and pain and

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inflammation, which could not be accounted for by the laceration of the wounds alone.

Dr. Antonio Porta in 1905 described a gland in the groove lying medially to the rows of teeth on either side, which he stated is similar to the gland found in *Scorpena*.

Major Evans's researches do not confirm Porta's description in all particulars. The examination of a series of sections shows a gland of a different type from that found in the Weevers, *Scorpena*, etc. The points emphasized are:—

(i.) The origin of the gland from a special epithelial structure at the base of the spine.

(ii.) The arrangement of follicles discharging their secretion by ducts or canals, communicating with the exterior by means of nipples or filaments.

(iii.) The arrangement of these nipples at the base of the teeth.

(iv.) The presence of muscular fibres surrounding the main canals which are instrumental in discharging the venom.

Mr. R. I. Pocock, F.R.S., F.Z.S., Curator of Mammals, read a paper, illustrated by lantern-slides, "On the External Characters of the Mongooses (Mungotidæ)," dealing principally with the ears, feet, and anal sac. Reasons were given for restoring the generic names *Ariela* for *Crossarchus fasciatus* and *Atilax* for *Mungos paludinosus*. It was also shown that the Mongooses differ from other Viverridæ in the structure of the ears, and that the type of ear in *Suricata* is different from that of all other genera of the family.

The next Meeting of the Society for Scientific Business will be held on Tuesday, May 9th, 1916, at half-past FIVE o'clock P.M., when the following communications will be made:—

EXHIBITIONS AND NOTICES.

MISS DOROTHEA M. A. BATE, Hon.M.B.O.U.

On a Small Collection of Vertebrate Remains from the Har Dalam Cavern, Malta, with Note on a new Species of the Genus *Cygnus*.

Dr. J. C. MOTTRAM.

An Experimental Determination of the Factors which cause Patterns to appear conspicuous in Nature.

The following Papers have been received :—

Miss OLIVE C. LODGE.

Some Enquiries into the Question of Baits and Poisons for Flies; being the Report on Experimental Work carried out during 1915 for the Zoological Society of London.

Miss WINIFRED H. SAUNDERS.

1. Report on Investigations into Stable Manure to check the Breeding of House-Flies, made during the Year 1915, for the Zoological Society of London.

2. Report on Trials for catching, repelling, and exterminating Flies in Houses, made during the Year 1915 for the Zoological Society of London.

3. Report on some Observations on the Life-History of the Blow-Fly and of the House-Fly, made from August to September 1915, for the Zoological Society of London.

The Publication Committee desire to call the attention of those who propose to offer Papers to the Society, to the great increase in the cost of paper and printing. This will render it necessary for the present that papers should be condensed, and be limited so far as possible to the description of new results.

Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,

Secretary.

ZOOLOGICAL SOCIETY OF LONDON,

REGENT'S PARK, LONDON, N.W.

April 25th, 1916.

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

May 9th, 1916.

Dr. S. F. HARMER, M.A., F.R.S., Vice-President,
in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

The SECRETARY read a Report on the Additions to the Society's Menagerie during the month of April 1916.

Mr. R. H. BURNE, M.A., F.Z.S., exhibited preparations from the Royal College of Surgeons Museum of various Teleostean Fishes†, showing connections of different kinds between the swim-bladder and the ear. The fishes belonged to several distinct families. In some (Berycidae, Gadidae, Hyodontidae, Notopteridae) the connection was shown to be by direct contact between a process of the swim-bladder and a fenestra in the periotic capsule, or even (Clupeidae) between the swim-bladder and part of the internal ear; while in others (Ostariophysi) it is indirect and the swim-bladder is connected with the perilymph spaces that surround the ear by a chain of ossicles (Weberian ossicles).

It was suggested that the above connections are probably an aid in the perception of sound, and, in furtherance of this view, specimens were shown of the "elastic spring" mechanism in several Siluroids, by which the walls and contained gases of the swim-bladder can be made to give rise to sonorous vibrations.

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† Presented to the College by Col. C. E. Shepherd.

Miss DOROTHEA M. A. BATE contributed a paper dealing with a collection of vertebrate remains from the Har Dalam Cavern, Malta. Birds are most numerous represented therein, and include some bones of an Anserine bird showing a reduction in its powers of flight. It is believed to be a hitherto-undescribed species, and is referred to the genus *Cygnus*. A list is given of all the species of vertebrates recorded from the Pleistocene cave and fissure deposits of the island.

Dr. J. C. MOTTRAM read a paper entitled "An Experimental Determination of the Factors which cause Patterns to appear conspicuous in Nature."

A series of experiments was carried out with artificial patterns and backgrounds under controlled conditions of lighting, and a large number of determining factors were discovered, both as regards plain and patterned objects and backgrounds. Finally, the experiments showed that the most conspicuous shape and pattern which an object can have, when viewed against a series of plain and patterned backgrounds, was presented by a circular disc of black, with a central circular area of white. Having arrived at this conclusion, the Indian diurnal Lepidoptera were completely examined, in order to discover whether any species presented patterns approaching this ideal conspicuous pattern. It was found that a considerable number presented patterns hardly removed from this ideal, and that a large proportion of these insects are considered to be "protected" species presenting "warning coloration."

The next Meeting of the Society for Scientific Business will be held on Tuesday, May 23rd, 1916, at half-past FIVE o'clock P.M., when the following communications will be made:—

E. G. BOULENGER, F.Z.S.

Exhibition of living specimens of the African Lungfish (*Protopterus annectens*) and of their Cocoons.

Lieut. R. BROOM, M.D., C.M.Z.S., R.A.M.C.

On the Structure of the Skull in *Chrysochloris*.

Dr. C. W. ANDREWS, F.R.S., F.Z.S.

Note on the Sternum of a Bird from the Eocene of Nigeria.

Dr. A. SMITH WOODWARD, F.R.S., V.P.Z.S.

On a Mammalian Mandible from the Cretaceous of Alberta, Canada.

V. LUTSHNIK.

1. List of Carabidæ (Coleoptera) collected in Chopersk District, South Russia.

2. A new Species of the Genus *Platysma* (Coleoptera) from China.

3. Notes on Species of the Genus *Platysma* from Australia.

The Publication Committee desire to call the attention of those who propose to offer Papers to the Society, to the great increase in the cost of paper and printing. This will render it necessary for the present that papers should be condensed, and be limited so far as possible to the description of new results.

Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,

Secretary.

ZOOLOGICAL SOCIETY OF LONDON,

REGENT'S PARK, LONDON, N.W.

May 16th, 1916.

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*
May 23rd, 1916.

Dr. HENRY WOODWARD, F.R.S., Vice-President,
in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

Mr. C. TATE REGAN, M.A., F.Z.S., exhibited a specimen of the rare fish, *Centrolophus britannicus* Günth., the fourth known example of this species.

Mr. Regan also exhibited a Silver Ling (*Molva elongata*), nearly 600 mm. long, taken from the stomach of a very large Sun-fish (*Mola mola*) that had been caught in a trawl, landed at Milford, and sent to Mr. W. Howlett of Billingsgate Market, who presented it to the Natural History Museum. The Sun-fish appears generally to swim near the surface and to eat small invertebrates, larval fishes, etc. It is interesting to note that it may descend to considerable depths (*M. elongata* is usually found at 100 to 300 fathoms) and that it may capture fairly large and active fish.

Mr. E. G. BOULENGER, F.Z.S., Curator of Reptiles, exhibited living specimens of the African Lungfish (*Protopterus annectens*).

The Rev. H. N. HUTCHINSON, M.A., F.Z.S., exhibited the plaster cast of a model, four feet long, which he had constructed, of the Dinosaur, *Diplodocus carnegiei*.

Lieut. R. BROOM, M.D., C.M.Z.S., R.A.M.C., read a paper on the structure of the skull in *Chrysochloris*.

Two stages in the development of the skull have been studied.

* This Abstract is published by the Society at its offices, Zoological Gardens, Regent's Park, N.W., on the Tuesday following the date of Meeting to which it refers. It will be issued, along with the 'Proceedings,' free of extra charge, to all Fellows who subscribe to the Publications; but it may be obtained on the day of publication at the price of *Sixpence*, or, if desired, sent post-free for the sum of *Six Shillings* per annum, payable in advance.

The earlier is that of a newly born *Chrysochloris hottentota*, whose skull has been cut into microscopic sections and reconstructed, and a somewhat later stage of *Chrysochloris asiatica*, whose skull has been prepared for the study of the membrane-bones. The following are the most interesting features discovered:—

External to the exoccipitals on each side is a large membrane-bone which partly covers the petrosal or periotic. This is believed to be the homologue of the bone which occurs in Therapsid and most primitive reptiles, and usually referred to as the tabular. The sections prove that it is no part of the auditory capsule.

Along the inner side of the prearticular or “goniale”—the little membrane-bone which supports the underside of the upper end of Meckel's cartilage—is a second membrane-bone, which, it is believed, has not been previously recognised in the mammal skull. This may be the homologue of the reptilian surangular.

Under the back part of the nasal capsule, and situated between the capsule above and the alisphenoid and pterygoid below, is a large membrane-bone of doubtful significance. It is probably the homologue of the “postero-lateral vomer” of Parker.

The skull is held to be in some respects highly specialised and in others degenerate, although also retaining a number of very primitive characters.

Dr. C. W. ANDREWS, F.R.S., F.Z.S., described an incomplete sternum of a gigantic carinate bird from the (?) Eocene of Nigeria. Comparison with the sterna of several groups of birds leads to the conclusion that this specimen, though differing considerably from the sternum of any living member of the group, belonged to a very large representative of the Tubinares. It has about twice the linear dimensions of the sternum of an Albatross, of which the spread of wing (in the flesh) was 10 ft. 8 in. It is proposed to refer this species to a new genus *Gigantornis*, the specific name being *G. eaglesomei* after its discoverer.

Dr. A. SMITH WOODWARD, F.R.S., V.P.Z.S., read a paper on a mammalian mandibular ramus from an Upper Cretaceous formation in Alberta, Canada. The specimen represented an opossum-like marsupial, and he referred it to a new species of *Cimolestes* named *C. cutleri* in honour of its discoverer, Mr. William E. Cutler. The close dental series behind the canine measured 30 mm. in length, and the molars differed from those of the two known species of the genus in their relatively less elevated trigonid. The fourth premolar was a large, tumid, laterally compressed cone, with one well-separated posterior cusp.

Mr. V. LUTSHNIK communicated the following three short Coleoptera papers:—(1) A List of Carabidæ collected in Chopersk District, South Russia, (2) On a new Species of the Genus *Platysma* from China, and (3) Notes on Species of *Platysma* from Australia.

Mr. E. G. BOULENGER, F.Z.S., Curator of Reptiles, described a new Lizard of the genus *Phrynosoma*, recently received among a small collection of reptiles presented to the Society by Dr. H. G. F. Spurrell, F.Z.S.

Dr. R. W. SHUFELDT, C.M.Z.S., communicated some notes on cases of albinism seen in American animals.

The next Meeting of the Society for Scientific Business, closing the Session 1915-1916, will be held on Tuesday, June 6th, 1916, at half-past FIVE o'clock p.m., when a Discussion will take place on the Results published in the 'Biologia-Centrali-Americana,' with special reference to the zoo-geographical relations between America and Africa.

The Discussion will be opened by Dr. F. DuCane Godman, F.R.S., F.Z.S., and, amongst others, the following will take part:—Dr. A. Smith Woodward, F.R.S., Dr. H. Gadow, F.R.S., Mr. C. Tate Regan, Mr. R. I. Pocock, F.R.S., and Dr. C. W. Andrews, F.R.S.

The following Papers have been received :—

JAMES F. GEMMILL, M.A., M.D., D.Sc., F.Z.S.

Notes on the Development of the Starfishes *Asterias glacialis* O. F. M., *Cribrella oculata* (Linck) Forbes, *Solaster endeca* (Retzius) Forbes, *Stichaster roseus* (O. F. M.) Sars.

S. MAULIK, B.A. (Cantab.), F.E.S.

On Cryptostome Beetles in the Cambridge University Museum of Zoology.

Sir JOHN A. S. BUCKNILL, M.A., F.Z.S.

Notes on the Lepidoptera of Cyprus.

The Publication Committee desire to call the attention of those who propose to offer Papers to the Society, to the great increase in the cost of paper and printing. This will render it necessary for the present that papers should be condensed, and be limited so far as possible to the description of new results.

Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,

Secretary.

ZOOLOGICAL SOCIETY OF LONDON,
REGENT'S PARK, LONDON, N.W.
May 30th, 1916.

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

June 6th, 1916.

Prof. E. W. MACBRIDE, D.Sc., F.R.S., Vice-President,
in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

An informal discussion on the results published in the 'Biologia-Centrali-Americana,' with special reference to the zoogeographical relations between America and Africa, was opened by Dr. F. DUCANE GODMAN, F.R.S., followed by Dr. H. GADOW, F.R.S., Dr. A. SMITH WOODWARD, F.R.S., Mr. C. TATE REGAN, Mr. R. I. POCKOCK, F.R.S., Dr. C. W. ANDREWS, F.R.S., Lord ROTHSCILD, D.Sc., F.R.S., Prof. J. P. HILL, D.Sc., F.R.S., Mr. W. L. SCLATER, Dr. R. BROOM, and the CHAIRMAN.

This Meeting closes the Session 1915-1916. The next Meeting of the Society for Scientific Business will be held on Tuesday, October 24th, 1916, at half-past FIVE o'clock P.M.

* This Abstract is published by the Society at its offices, Zoological Gardens, Regent's Park, N.W., on the Tuesday following the date of Meeting to which it refers. It will be issued, along with the 'Proceedings,' free of extra charge, to all Fellows who subscribe to the Publications; but it may be obtained on the day of publication at the price of *Sixpence*, or, if desired, sent post-free for the sum of *Six Shillings* per annum, payable in advance.

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On Cryptostome Beetles in the Cambridge University Museum
of Zoology.

H. G. NEWTH, A.R.C.S., F.Z.S.

The Early Development of *Cucumaria*: Preliminary Account.

R. E. TURNER, F.Z.S., F.E.S.

Notes on the Wasps of the Genus *Pison* and some allied
Genera.

F. E. BEDDARD, M.A., D.Sc., F.R.S., F.Z.S.

On Two new Species of Cestodes belonging respectively to
the Genera *Linstowia* and *Cotugnia*.

The Publication Committee desire to call the attention of
those who propose to offer Papers to the Society, to the great
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P. CHALMERS MITCHELL,
Secretary.

ZOOLOGICAL SOCIETY OF LONDON,
REGENT'S PARK, LONDON, N.W.
June 13th, 1916.

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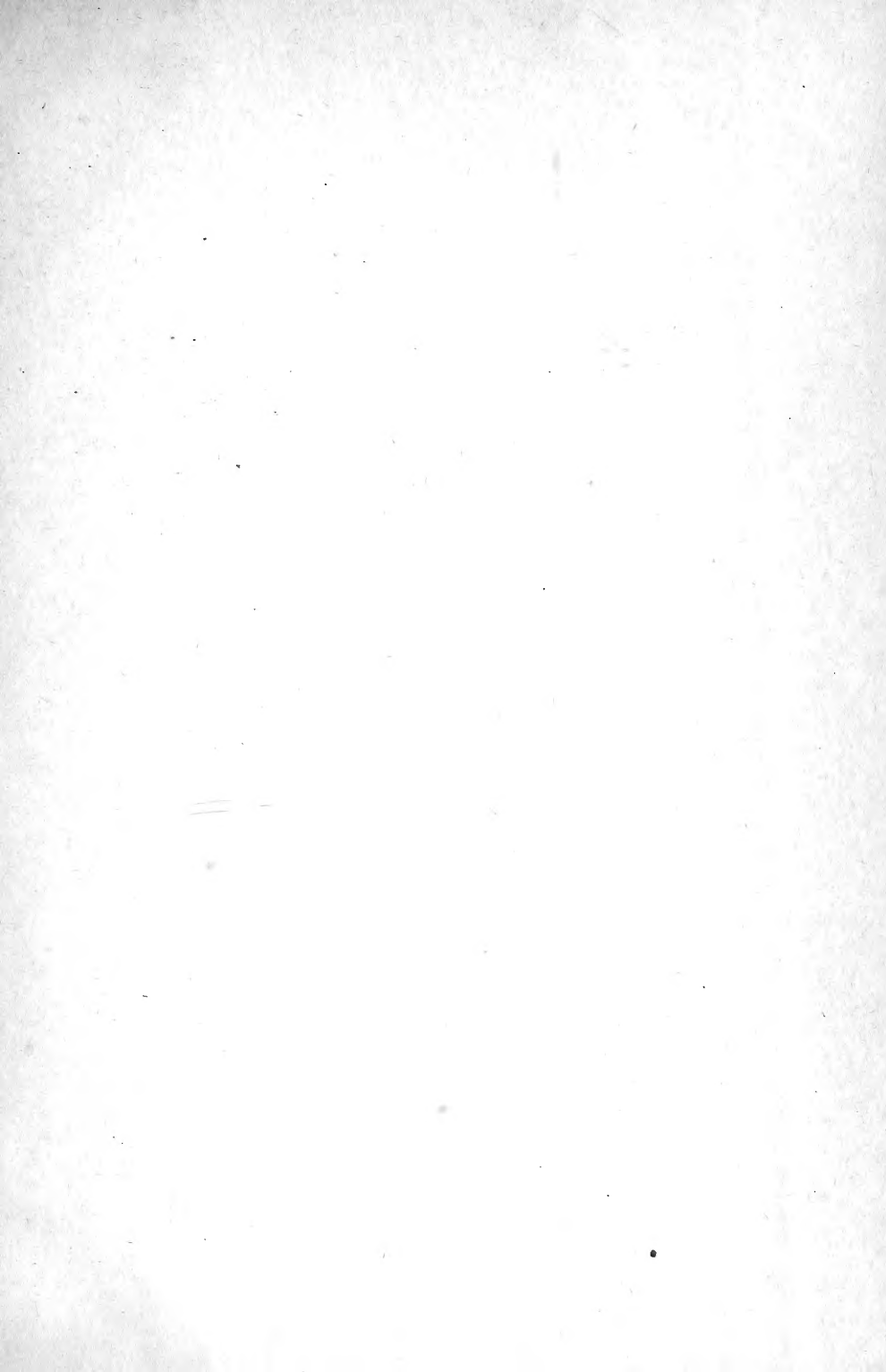
The 'Proceedings' for the year are issued in *four* parts, paged consecutively, so that the complete reference is now P. Z. S. 1916, p. . . . The Distribution is usually as follows:—

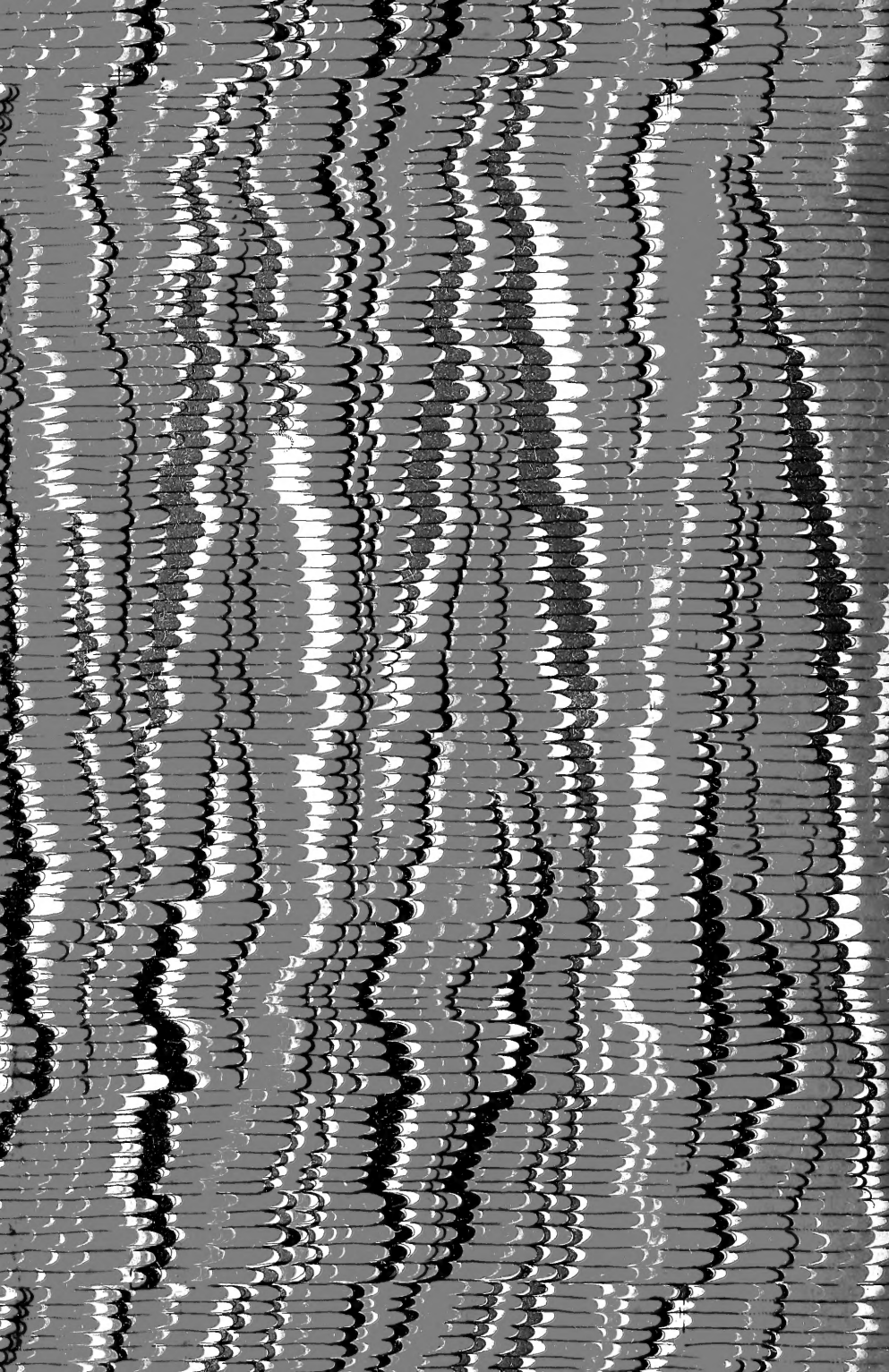
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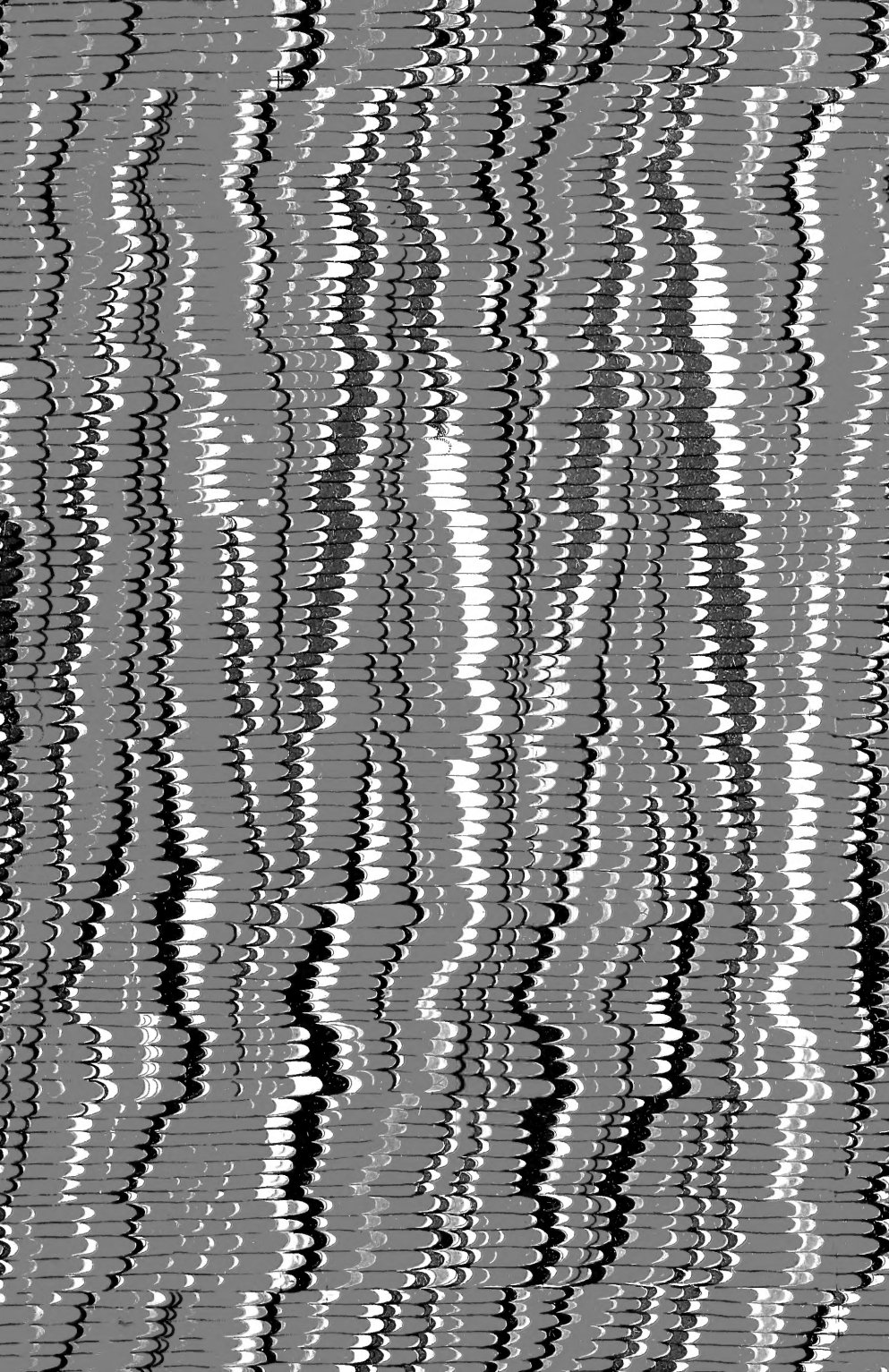
'Proceedings,' 1916, Part I. (pp. 1-307), were published on April 20th, 1916.

The Abstracts of the 'Proceedings,' Nos. 155-159, are contained in this Part.

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